LANDOWNERS' PERCEPTIONS ON COORDINATED WILDLIFE AND GROUNDWATER MANAGEMENT IN THE EDWARDS PLATEAU

A Thesis

by

CRAIG MILTON LIMESAND

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2006

Major Subject: Rangeland Ecology and Management

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Approved by:

Chair of Committee, Urs P. Kreuter
Committee Members, Fred E. Smeins
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ABSTRACT

Landowners' Perceptions on Coordinated Wildlife and Groundwater Management in the Edwards Plateau. (August 2006)

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Chair of Advisory Committee: Dr. Urs P. Kreuter

Since Texas contains less than 5% public land, private landowners are critical to the success of environmental management initiatives in the state. This has implications for resources that traverse property boundaries, such as wildlife and groundwater. Texas landowners are increasingly capitalizing on the income potential of fee-based hunting, and many have banded together to form Wildlife Management Associations (WMAs). Not only can such landowner associations enhance the coordination of resource management decisions, they also have the potential to increase social capital, which is reflected by interpersonal trust, reciprocity and civic participation. To improve the management of common-pool resources it is important to understand the relationship between social capital and coordinated resource management because long-term community stability and resource sustainability appear to be highly correlated.

A 600-landowner mail survey (with 48.1% response) was conducted in the Edwards Plateau region of Texas to compare the land management characteristics and social capital of landowners who are members of WMAs with non-member landowners. The goal of this research was to determine how WMA membership, property size, and location affect levels of social capital and interest in cooperative resource management.

It was hypothesized that members, large landowners, and northern landowners would be more interested in cooperative management and exhibit higher social capital.

While WMA members and large-property owners were more involved in wildlife management than non-members and small-property owners, this interest in resource management did not carry over to groundwater. These groups were not more involved in groundwater management activities, and all survey groups were disinterested in joining private cooperatives for groundwater marketing.

Social capital differences were more evident between large- and small-property owners than between WMA members and non-members. Members scored higher only on community involvement, while large owners scored higher on community involvement as well as trust. These results suggest that WMA membership per se does not significantly increase social capital among Edwards Plateau landowners, but do not necessarily refute the importance of social capital within WMAs. Differences in trust between members were positively correlated with increased communication and meeting frequency, suggesting ways WMAs can improve intra-association social capital.

DEDICATION

To MacKenzie, because my greatest accomplishment during my time at Texas A&M was not a degree or an award; instead it was convincing you to marry me.

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I would like to thank my committee chair, Dr. Urs Kreuter, for his assistance throughout my graduate career. From showing me around town during my first visit, helping me find funding, advising me on courses, and editing my thesis, to helping me find a job, you have been an exemplary graduate advisor. I would recommend you to any prospective graduate student.

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CHAPTER I

INTRODUCTION

The state of Texas contains less than 5% publicly owned land. As a result, private landowners are key to any environmental management initiatives in the state because they are the primary decision makers for most of the land. A primary objective of most private landowners is economic profitability. Accordingly, to be accepted by landowners, any private-lands conservation program that enhances income generation will likely facilitate fast, widespread acceptance of a properly incentivized conservation program. An example of this is the federal Conservation Reserve Program, created in the 1980's. Upon creation of this program, which paid farmers to take marginal cropland out of production, millions of acres of farmland were restored to rangelands, reducing soil erosion and increasing wildlife habitat. There are currently 40 million acres enrolled in CRP (Anderson 2005).

In Texas, numerous landowners who see the income potential of fee-based hunting have banded together to manage their properties cooperatively to maximize wildlife habitat. In this manner, both economic and environmental goals can be simultaneously met on private lands. Along with economic incentives, however, another factor may be necessary for cooperative management associations to succeed. This is social capital, which is reflected by trust in neighbors, a willingness to actively

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This thesis follows the style of *Journal of Rangeland Ecology & Management*.

participate in social and service organizations, and an interest in the long-term viability of the community, all of which are factors that contribute to the effectiveness of cooperative ventures.

Cooperative management has several advantages. The relationships that are built between landowners lower transaction costs, making joint ventures more feasible. These relationships also build confidence among individuals, who will be more likely to engage in conservation activities knowing that others are involved. Trust also reduces the need for intensive monitoring of regulatory compliance. Cooperative management has led to sustainable use of resources such as forests, irrigation water, and fisheries, which leads to increased long-term economic benefit, and reduces the likelihood of government intervention.

Groundwater is a prime candidate for cooperative management. Groundwater stocks are limited, and no incentive for conservation exists in Texas' current groundwater regulatory system, which is driven by the "rule of capture" (House Research Org. 2000). Furthermore, demand for groundwater is already high, and will increase in future years as the state's population grows. Individual landowners, however, seldom have sufficient groundwater pumping capacity or infrastructure to meet the demands of growing populations. Even if individuals could enter into contracts to sell groundwater, a race against neighbors to the bottom of the well would lead to faster depletion of aquifers. A cooperative, sustainable water marketing plan could provide an additional income stream to rural landowners, while conserving the resource and meeting growing urban water needs.

This income stream could have an impact on another wildlife issue, that of land fragmentation. As urban residents become increasingly interested in purchasing rural acreage, development prices of this land increase, putting more pressure on rural landowners to sell their land for subdivision. This causes wildlife habitat to be fragmented, and thus less able to support wildlife. Large land parcels are better for most species, and management is easier if there is only one landowner making decisions, instead of multiple landowners in a fragmented area. If insufficient property income is forcing a landowner to sell against his or her will, the additional income stream provided by groundwater marketing may allow the landowner to keep the land intact, to the benefit of wildlife in the area.

The research project presented here examines existing wildlife cooperatives, and the factors that influence their popularity and success. In addition, the feasibility of extending the function of these cooperatives to the management of groundwater will be investigated. If social capital can be built, and economic potential can be recognized, cooperative management may be a very effective method to simultaneously manage wildlife habitat and groundwater in a socially beneficial and sustainable manner.

Problem Statement

Increasing population growth in Texas is placing increasing pressure on the state's water supplies, and increasing shortages are forecast in the near future. Environmentally deleterious effects of the lowering of water levels in aquifers, especially the Edwards Aquifer, have already been experienced. Population growth has

also raised the development value of rural lands, as more numerous urban dwellers seek this land for non-traditional use, mainly recreation. This has led to land fragmentation, which adversely affects wildlife habitat by breaking it up, forcing wildlife to cross more property boundaries and open areas to find suitable habitat.

Water marketing is a potential solution to the problem of efficient allocation of water, due to the current "rule of capture". Since each landowner effectively owns the water underneath his land, he or she theoretically has the right to transfer that water to another user without obtaining government consent. Establishing a coordinated market for groundwater could provide a solution for water shortages in growing urban areas while providing a new income stream for rural landowners whose land overlies aquifers. This income could make it easier for landowners to retain ownership of their land, thus reducing further fragmentation.

Landowner cooperatives are a potential vehicle for organizing landowners and increasing the efficacy and sustainability of water marketing ventures, while also protecting and/or improving wildlife habitat. No comprehensive study has been conducted on the Edwards Plateau to identify factors that influence coordinated decision-making among landowners, or to what extent these decisions might increase participation in water marketing or decrease incentives to sell rural land.

One factor that plays a role in the success of cooperative ventures is social capital, a measure of social networks between people. Inherent social capital may encourage people to join organizations, and social capital within an organization may make it stronger and more successful. Absentee landowners, decreasing membership in

civic groups, and increasing reliance on electronic forms of entertainment have decreased social capital in this country. Landowner cooperatives may provide a way for rural landowners to build social capital and thus gain confidence and interest in cooperative management ventures.

Objectives and Hypotheses

The purpose of this study is to examine the perceptions and attitudes of rural landowners in the Edwards Plateau of Texas towards cooperative resource management. It assesses the demographic composition of landowner cooperatives and the social benefits derived from the establishment of such cooperatives. By comparing cooperative members to non-members, the study will examine whether the formation of such landowner associations is a feasible option for conserving wildlife habitat, increasing social capital, reallocating groundwater, and preventing land fragmentation.

The hypotheses that will be tested in this study are:

- H1: Landowner association membership leads to increased investment in habitat improvement and land management.
- H2: Members of landowner associations show a greater willingness than non-members to enroll in other cooperative management initiatives.
- H3: Members of landowner associations are willing to enter into coordinated groundwater marketing arrangements.

- H4: Large-property owners are more interested in wildlife management and groundwater marketing than small-property owners, and exhibit more social capital.
- H5: Landowners in the northern Edwards Plateau, who are less subject to fragmentation pressure than southern landowners, exhibit more interest in wildlife management and groundwater marketing, and exhibit more social capital.
- H6: Landowner associations increase social capital (trust, community involvement, reciprocity).

CHAPTER II

LITERATURE REVIEW

Land, Water, and Wildlife Habitat Dynamics in Texas

If the population of Texas is to continue growing as currently projected, water supply is a limiting factor that will have to be considered. The population of Texas is expected to nearly double to 40 million people by 2050, (TWDB 2002). During this time, water usage is expected to grow from 15.4 million acre-feet (in 1997) to over 20 million acre-feet. However, sustainable water supply in 2050 is only estimated to be 14.9 million acre-feet. Most of the state's surface water is already allocated, and as a result of the "rule of capture" law regarding groundwater, those who own land may use as much of the groundwater under their land as they can extract, provided they do not waste it. Accordingly, the January 1999 report of the Texas House of Representatives' Joint Interim Committee on Water Resources Development and Management cited water availability as "the single most important factor for the future economic vitality of Texas." (House Research Org. 2000).

As the population of Texas has grown, it has also become increasingly urbanized (Governor's Task Force 2000). Cities have increasingly turned to groundwater to meet the needs of residents. For example, the city of San Antonio depends on groundwater from the Edwards Aquifer as its primary water source (House Research Org. 2000). Irrigation currently accounts for 80% of groundwater use, but this is expected to drop to 59% by 2050 (TWDB 2002) while the demand for municipal use will grow and urban

areas may experience persistent shortages as soon as 2010 (House Research Org. 2000). Thus, there will be increasing pressure to reallocate groundwater to meet growing urban demand, which is expected to double to 30% of total groundwater use by 2050.

The shift in population in Texas has also led to an increase in the subdivision and development of rural lands, as the development value of land outstrips its production value. The median price of rural lands increased by about 35% from 1992 to 1997, due to the weakening of the agricultural economy and increasing demands of urban populations (Wilkins et al. 2000). There is a direct link between nonagricultural land value (market price of land minus production value per acre) and rate of fragmentation (Kjelland et al. 2003). This is demonstrated by the fact that fragmentation is more prevalent in areas surrounding large cities in east and central Texas. Texas led the nation in loss of undeveloped land from 1992-1997, during which time 1.2 million acres of rural land were developed (USDA, 1997). In contrast, rural property size decreased by an average of 4% between 1985 and 1995, and 80% of Texas' farms and ranches are smaller than 500 acres (Conner and James 1996). This fragmentation affects habitats by altering landscape scale processes, such as fire, and by reducing local native species populations (Leach and Givnish 1996). Fragmented lands are less likely to support native flora and fauna. As a result, the Governor's Task Force on Conservation (2000) identified land fragmentation as "the greatest single threat to our wildlife habitat and to the long-term viability of agriculture in Texas." In addition, the increasingly smaller parcels of land are more frequently owned by absentee landowners and more likely to be subdivided further than larger land parcels (Wilkins et al. 2000).

Aquifers of the Edwards Plateau

The study area for this project lies atop several major and minor aquifers, which overlap each other in many places. The characteristics of these aquifers differ in recharge rate, size, transmissivity, and primary use. While major studies have been done on major aquifers in Texas, little work has been done on the relevant minor ones.

Kerr and Bandera Counties, and part of Gillespie county, are within the contributing zone of the Edwards (Balcones Fault Zone) aquifer, one of nine major aquifers in Texas (Ashworth and Hopkins 1995). Precipitation that falls in these counties flows via rivers and streams south to the recharge zone, which extends from Bracketville, in Kinney county, in an arc to the northeast, ending near Austin. The aquifer as a whole covers an area of about 4,350 square miles beneath parts of 11 counties, and over half of the water pumped from it is used for municipal purposes (Ashworth and Hopkins 1995).

These three counties are also served by two other major aquifers. A line running from southwest to northeast, starting at about the midpoint of Bandera County's southern border and running through Kerr to Gillespie County, roughly separates the section of these counties lying above the Edwards-Trinity (Plateau) aquifer (west of the line) and the Trinity aquifer (east of the line) (Mace and Angle 2004). The Edwards-Trinity aquifer provides water, 70% of which is used for irrigation, to all or parts of 38 counties (Ashworth and Hopkins 1995). Recharge, which is addition to an aquifer through percolation of precipitation, has been estimated at 776,000 acre-feet per year for the Edwards-Trinity aquifer (Muller and Price 1979).

The Trinity aquifer extends from Bandera and Medina counties in the Hill Country in a northeasterly direction to Lamar and Red River counties in north Texas. Bandera, Kerr, Gillespie, Lampasas, and Coryell are the counties in this study that lie above this aquifer. The yield of the Trinity is lower than other major Texas aquifers. For example, the Edwards (BFZ) aquifer, just south of the Trinity, yields about 250 times more water than the Trinity (Mace et al 2000). Development in the area served by the Trinity is accelerating, and this has led to falling water levels. A drop of 550 feet has been seen in the Dallas-Fort Worth area, and levels have dropped 400 feet near Waco (Ashworth and Hopkins 1995).

A characteristic measure of an aquifer is transmissivity, which is a function of the thickness and conductivity of the formations that make up an aquifer. The transmissivity value for the Edwards aquifer ranges from 200,000 to 2 million square feet per day. This value is 100 to 58,000 ft^2/d for the Trinity, and is estimated at 100 to 12,000 ft^2/d for the Edwards-Trinity aquifer (Kuniansky and Holligan 1994).

Current and projected future groundwater withdrawals (in acre-feet) from the Edwards-Trinity and Trinity aquifers for the three relevant counties are shown in Table 1 (Mace et al 2000).

Table 1: Current and projected future groundwater withdrawals (in acre-feet) from the Edwards-Trinity and Trinity aquifers in three central Texas counties.

County	**2000**	**2020**	**2050**
Bandera	3,095	4,598	6,070
Kerr	5,247	5,995	7,623
Gillespie	2,011	2,052	2,239

The Ellenburger-San Saba and Hickory aquifers, two of the 20 minor aquifers in Texas, both encircle the Llano Uplift in Llano and Mason counties (Ashworth and Hopkins 1995). Gillespie, Kerr, San Saba, and Lampasas are the counties in this study that utilize these aquifers. Pumping from the Ellenburger-San Saba produces about 5,000-7,500 acre-ft/yr, mainly for municipal use. The Hickory provides more water per year, 17,000-28,000 acre-ft, most of which is used for irrigation (Mace and Angle 2004), although municipal use is beginning to cause water-level declines in Mason and Gillespie counties. Average annual recharge for these aquifers is 46,149 acre-feet for the Hickory and 34,912 for the Ellenburger-San Saba aquifer (Smith 2004).

Some hydraulic connections exist between these aquifers. For example, the Edwards-Trinity is connected to the Trinity and the Edwards (BFZ), and also to the Ellenburger-San Saba and Hickory aquifers (Anaya 2004). Groundwater moves from the Trinity to the Edwards (BFZ), although the precise amount is unclear (Mace et al 2000).

Groundwater Conservation Districts

In 1947, the Texas Legislature authorized the creation of groundwater conservation districts (GCDs) for the purpose of conserving and managing groundwater supplies. The High Plains Underground Water Conservation District was the first GCD, established in 1951. In 1997, the legislature amended the Texas Water Code to recognize GCDs as the "preferred method of determining, controlling, and managing groundwater resources (Brock and Sanger 2003). By 1999, there were 63 districts covering 37% of the state (House Research Org. 2000). Generally, GCDs require landowners to acquire permits for their wells. Low-capacity wells (below 25,000 gallons/day) used for domestic and livestock purposes are exempt. The districts regulate well spacing and address water waste and conservation. Because of the rule of capture, however, GCDs have little real power to limit groundwater extraction (Kaiser 1986).

Five GCDs have been established in the study area of this project in the Edwards Plateau. They are the Hickory Underground Water Conservation District (UWCD) in San Saba County, the Saratoga UWCD in Lampasas County, the Hill Country GCD in Gillespie County, Headwaters GCD in Kerr County, and Bandera County River Authority/Ground Water District in Bandera County (Mace and Angle 2004).

The Headwaters GCD was formed in 1991 by the state legislature. The boundaries of the district correspond with the boundaries of Kerr County. The district has used scientific studies to determine the amount of available groundwater, as well as current and future demand. These studies suggest that demand will exceed supply by 2010. The district uses state minimums for spacing wells from contamination sources,

and also requires wells to be spaced at least 75 feet from property lines. The district also requires permitted wells to be metered, and also that exported water must be transported by pipe if moved over ½ mile. Export permit applications are evaluated based on availability of alternative supply, as well as the amount and purpose of use in the receiving area. The district enforces pumping and waste limits, and reserves the right to deny permit applications based on these criteria.

The Headwaters GCD is funded by a property tax of $0.01 per $100 valuation, and has an annual budget of $268,000 (Brock and Sanger 2003).

Groundwater Management

Land fragmentation can also lead to increased groundwater extraction. An issue that complicates attempts to reallocate groundwater supplies is the "rule of capture", which has been in place in Texas since 1904, and was upheld by the Texas Supreme Court in 1999 (Ashley and Smith 1999). Under this doctrine, a landowner can pump as much water as he/she chooses, as long as water is not wasted or pumped in order to maliciously injure a neighbor. Texas is the only state that manages groundwater in this manner. The rule of capture essentially makes groundwater a common-pool resource. Thus, as aquifer levels drop, the incentive exists to extract as much water as possible before it runs out. Any individual efforts to conserve are futile, because neighboring landowners are free to use any conserved water.

An exception to this rule is the Edwards (Balcones Fault Zone) Aquifer. Residents of six counties pump water from the Edwards, and it is the sole source for the

city of San Antonio (Merrifield 2000). The Aquifer is also important for wildlife (including seven endangered species), recreation, and for providing base flow for rivers. It feeds two springs, Comal and San Marcos, which provide habitat for endangered aquatic species. After two consecutive years of reduced spring flow, due to drought and excessive pumping, the Sierra Club filed a lawsuit against the US Fish and Wildlife Service under the Endangered Species Act in 1991 to force Texas to manage the aquifer for adequate spring flow (Kaiser and Phillips 1998). As a result, the state legislature passed the Edwards Aquifer Authority Act in 1993. The Edwards Aquifer Authority (EAA), formed in response to the Act, was given wide powers to regulate groundwater withdrawal in the area above the aquifer (Wagner & Kreuter 2004). The Act limited total annual withdrawals to 450,000 acre-feet, and required users to acquire permits.

The Edwards Aquifer, located in central Texas, has several unique features. Its water levels can change quickly, due to its limestone composition and rapid recharge rate (Kaiser & Phillips, 1998). For example, in 1988 the Aquifer reached its lowest level in 30 years, 627 feet, but only four years later, after heavy rainfall, it reached a record high of 703 feet, as measured by the J-17 index well (EAA 2005). Average annual recharge to the Aquifer is about 640,000 acre-feet, but this can vary from 43,000 to over 2 million acre-feet (Kaiser & Phillips 1998). The limestone composition also allows for the rapid movement of water within the aquifer.

One method allowed under the EAA to reallocate groundwater is the marketing of water rights within the boundaries of the aquifer. By giving water rights holders the ability to sell or lease these rights on the free market, water should be able to efficiently

move to its highest economic use. Efficiency exists when the marginal net benefit, the gain from applying the last unit of water, is the same for all users. This is achieved when no reallocation of water will further increase net benefits (Merrifield 2000). For example, because irrigation provides a lower net benefit than other water uses under a free market system, this water used for irrigation would be more valuable if it were transferred for municipal and other uses than if it were used to irrigate crops.

Water markets have already been implemented in many places. An example of an early, well-established water market is the Colorado-Big Thompson Project in northeast Colorado (Michelsen 1994). In this market, 310,000 shares were allocated. Each share is worth up to an acre-foot of water, depending on each year's total allowable extraction, as established by the regional water conservation district. These shares are freely transferable, and between 1970 and 1993 about one-third of the shares changed hands or type of use. During this time, agricultural users were the primary sellers and the percentage of shares owned by agriculture dropped from 82% to 55%.

Water call markets also create incentives to conserve groundwater (Zilberman et al. 1994). Users that pay for water by the acre-foot are more likely to use it frugally than users that have a right via prior appropriation or reasonable use doctrines.

Along with providing water to growing cities, Kaiser (1994) lists six other positive results of water transfers. They 1) are a tool to manage drought; 2) promote efficient water use; 3) promote water conservation; 4) provide water for environmental needs and recreational use; 5) offer an alternative to reservoir construction; and 6) promote political harmony.

Concerns of Transferring Rural Water

Despite the potential economic benefits, concerns exist that may discourage rural water rights holders from participating in water marketing. One such concern is that cities will become dependent on water leased from landowners, and at some point attempt to take the water through eminent domain. Others worry that if water is put to economic use outside of the region of origin, it will detrimentally affect the local rural economy, because of an associated decline in crop production and rural income and a loss of farm jobs (Phillips 1996). In turn, this could lead to reduced property tax revenue for affected counties, and it could affect bonding capacity and debt limits, as well as reducing the county's share of state sales tax revenue (NAS 1992).

One possible method of allaying fears of rural water users and promoting water marketing is the formation of water cooperatives. As members of such groups, landowners would agree to manage water collectively, agreeing to limit their own use, while sharing the costs and benefits of transferring water to urban areas. There are many instances in which cooperative management of common-pool resources has led to sustainable, mutually beneficial resource use (Ostrom 1998). Cooperative management presents a remedy to the "tragedy of the commons", hypothesized by Hardin in 1968, which states that increasing use of open-access common pool resources inevitably leads to their overuse and degradation. Integration of decision making regarding the use of common-pool resources through the use of common-pool resources through the creation of management cooperatives reduces individuals' incentives to extract as much of the resource as possible before another independent decision-maker uses it.

Wildlife Management

The Edwards Plateau of Texas is one of the best-known whitetail deer (*Odocoileus virginianus)* producing areas in the world (Armstrong and Young 2000). Texas has more whitetail deer than any other state, and an estimated 430,000-500,000 deer are harvested by hunters every year (Cook 1992). Over 40% of Texas deer are found in the Edwards Plateau (Young and Traweek 1999).

Overall, $1.5 billion was spent on hunting in Texas in 2001 (USFWS 2001). Since Texas has developed what is thought of as one of the most efficient systems of lease and fee-based hunting (Benson et al. 1999), a large part of this expenditure went to buy access rights to private lands for hunting. In 1987, Texas landowners received from $100-$300 million from hunting fees (Freese and Trauger 2000). The Edwards Plateau had the most landowner-managed hunting operations in Texas, and the most leased acres (4.7 million), according to a 1990 survey (Thomas et al. 1990). The average lease rate varies widely and ranges from $0.58 per acre in Cameron County to $14.63 per acre in Willacy County, while the mean value of the lease rate in Texas is $6.01 per acre (Mozumder et al. 2004).

The Texas Department of Parks and Wildlife provides wildlife management guidance to private landowners through several programs, including the Private Lands Enhancement Program, which provides technical guidance; the Public Hunting Program, which leases private lands for public hunting; and the Hunters Clearinghouse Directory, which lists available private hunting leases (Benson et al. 1999).

Landowner Cooperatives

Common interest in improving deer management and resources available through TPWD programs has led to increasing cooperation among landowners to improve deer habitat. A model for voluntary landowner cooperatives currently exists in Texas in the form of Wildlife Management Associations (WMAs). Members of these groups voluntarily agree to manage their lands according to a Texas Parks and Wildlife Department (TPWD) Wildlife Management Plan (TPWD 1998). Since the organization of the first WMA in Texas in 1973, over 150 WMAs have been formed in the state, covering over 1.8 million acres. The popularity of WMAs stems from the increased value of wildlife enterprises in Texas. Hunters spent $1.3 billion dollars on the activity in Texas in 1996 (USFWS 1996), and a goal of WMAs is to increase the quantity and quality of wildlife on enrolled land. Landowners may also join WMAs due to their interest in improving local habitat and ecosystems, or to share common interests with neighbors (TPWD 1998). In the five years after "wildlife management" was designated as an agricultural land use in 1996, the designated acreage rose 60%, from 91,000 to 480,000 (Kjelland et al. 2003).

Just as the formation of wildlife cooperatives has resulted in sustainable yet profitable management of wildlife, water cooperatives may have the potential to do the same thing for groundwater (Wagner & Kreuter, 2004). By managing land cooperatively to meet growing urban water demand, landowners can increase their income, reduce fragmentation by increasing the production value of their land, and

sustainably manage aquifer levels. In addition, wildlife cooperatives may also enhance social capital in rural communities.

Social Capital and Environmental Management

Social capital, a concept that has been well-studied in the last decade, is an important component of the success or failure of organizations, clubs, and communities. Social capital refers to social networks and the norms of reciprocity and trustworthiness that arise from them (Putnam 2000). Four important aspects of social capital have been identified; relations of trust, reciprocity and exchanges, common norms, rules, and sanctions, and networks and groups (Pretty and Ward 2001). These features combine to create durable, long-term human relationships that are not easily eluded. Membership in networks, frequency of meeting attendance, labor input, and participation rate are some of the most frequently used proxies for social capital (Rodriguez and Pascual 2004).

Increased social capital has numerous positive effects for communities. Households with greater connectedness tend to have higher incomes, higher education, increased longevity, improved social cohesion and better links with government (Pretty and Smith 2004). Greater social capital is generally also associated with better child development, neighborhood safety, and career advancement (Putnam 2000). Such benefits, however, are not limited to those directly connected to others. "Externalities" exist, by which non-connected members of a community receive some of the benefits, such as a safe neighborhood or good education system.

Increased social capital tends to lead to greater cooperation, reduce transaction costs, and encourage investment in collective activities. Along with knowledge of local resources and appropriate institutional, social, and economic conditions, social capital gives communities the potential to engage in effective management of natural resources (Pretty 2003). Local groups that exhibit elevated social capital show great promise for sustainable management of common resources (Pretty 2002). For example, common-pool resources, such as fisheries or groundwater, are susceptible to free-riders, who overuse and/or underinvest in such resources. If a group or community has strong connections, cultural norms, social obligations, and exclusionary rights, free-rider problems can be reduced, and members will feel confident in investing in the resource.

D'Silva and Pai (2003) studied local forest-management groups in India, and compared the success of different groups to their level of social capital. They found that two groups with high social capital, as measured by ten indicators, were more successful than a third group with less social capital. While strong local leadership and dependable public institutions can help build cohesion, the study concluded that cooperative management programs work best when an "underlying tendency for united action already exists" in the community.

Pretty and Ward (2001) found that governments and policy play a role in the formation and maintenance of environmentally-based collective management groups. Policies must be favorable to the emergence of these community organizations. In India and Nepal, national governments granted rights and access to forest products to community groups. This played a large role in the subsequent emergence of 20,000 such

groups. In Texas, the Texas Parks and Wildlife Department offers technical guidance to Wildlife Management Associations, assisting them in providing better wildlife habitat. Dietz, Ostrom, and Stern (2003) identified five factors that make commons governance easier to achieve, all of which are facilitated by elevated social capital. These are:

> 1) resources and their use can be monitored at low cost; 2) rates of change in resources, resource-user populations, technology, and economic and social conditions are moderate; 3) communities maintain dense social networks; 4) outsiders can be excluded at low cost; and 5) users support effective monitoring and rule enforcement.

While few situations boast all five of these factors, policies can be enacted to help increase some of them. Allowing and providing for the exclusion of outsiders is the most likely example. Also, the above examples suggest that governments can in small ways encourage the creation of social capital, a powerful phenomenon that can have many positive effects. By directing this force towards environmental problems, citizens and policymakers can create and enact efficient, effective solutions that are beneficial to the environment and the community.

Landowner Surveys

Mail surveys area a commonly-used method of gauging landowner opinions regarding natural resources, conservation issues and land management practices. Several surveys have been conducted in recent years by the Department of Rangeland Ecology and Management, Texas A&M University to measure different aspects of natural resource management.

Three surveys explored landowner willingness to adopt brush management practices (Amestoy 2002) and enroll in government cost-share programs for brush management (Tays 2001, Narayanan 2004) in different parts of Texas. These surveys resulted in 45-58% response. Davis (2005) also examined landowner opinions regarding cost-share programs related to improvement of ecosystem services, including the supply of increased water yields, improved wildlife habitat and increased carbon sequestration. Her survey, which was sent to respondents to a previous questionnaire, received 68% response.

Nair (2004) studied property rights orientations of landowners, and the effect that these orientations had on willingness to implement certain management practices. Woodard (2005) studied landowner perceptions of prescribed fire, barriers to fire use, and how to increase use of fire. These surveys received 51.3% and 46.6% response rates, respectively.

Wagner (2005) studied property characteristics, demographics, and association characteristics of Wildlife Management Association members in the Lower and Central Post Oak Savannahs in east-central Texas, and examined how these factors affect social capital in a study conducted under the Department of Landscape Architecture and Urban Planning at Texas A&M University. He found that association size, number of meetings, and longevity of ownership positively affected social capital, while absentee ownership and amount of wooded habitat had negative effects. This project is based largely on Wagner's study, which has been expanded here to compare association members to non-members in the Edwards Plateau.

CHAPTER III

METHODOLOGY

Study Area

The Edwards Plateau is a region of central Texas extending from Austin and San Antonio in the east and south to the mountains of West Texas and north into the High Plains (Mace et al 2004). Elevation ranges approximately 2,000 to 3,000 feet above sea level. Annual rainfall ranges from 15-25 inches. Vegetation in this region consists of live oak (*Quercus virginiana* Mill.), shin oak (*Quercus sinuate* Torr.), Ashe juniper (*Juniperus ashei* Buchh.), mesquite (*Prosopis glandulosa* Torr.), and short grasses. The Edwards Plateau has historically been used primarily for ranching (Reese and Kennamer 1978). Sheep, goats and cattle are grazed on land that, due to its shallow soils, is unsuited for agriculture (Handbook of Texas Online, 2001). The area was originally a grassland savannah, but fences, overgrazing, and fire control have allowed brush species to increase in abundance (TPWD 2005). The Hill Country, in the southeastern part of the Edwards Plateau, is experiencing rapid population growth as people move out of nearby urban areas. Six of the nation's fastest growing counties between 2000 and 2005 are in the Hill Country (U.S. Census 2006).

County Selection

Three northern-Plateau counties (Coryell, Lampasas, and San Saba) were selected for inclusion in the study, along with three southern-Plateau counties (Bandera, Gillespie, and Kerr) (Fig. 1). These counties were selected based on location and response from associations and appraisal districts to member list requests. Twelve WMAs that provided member contact information within these counties were selected for extraction of the survey sample.

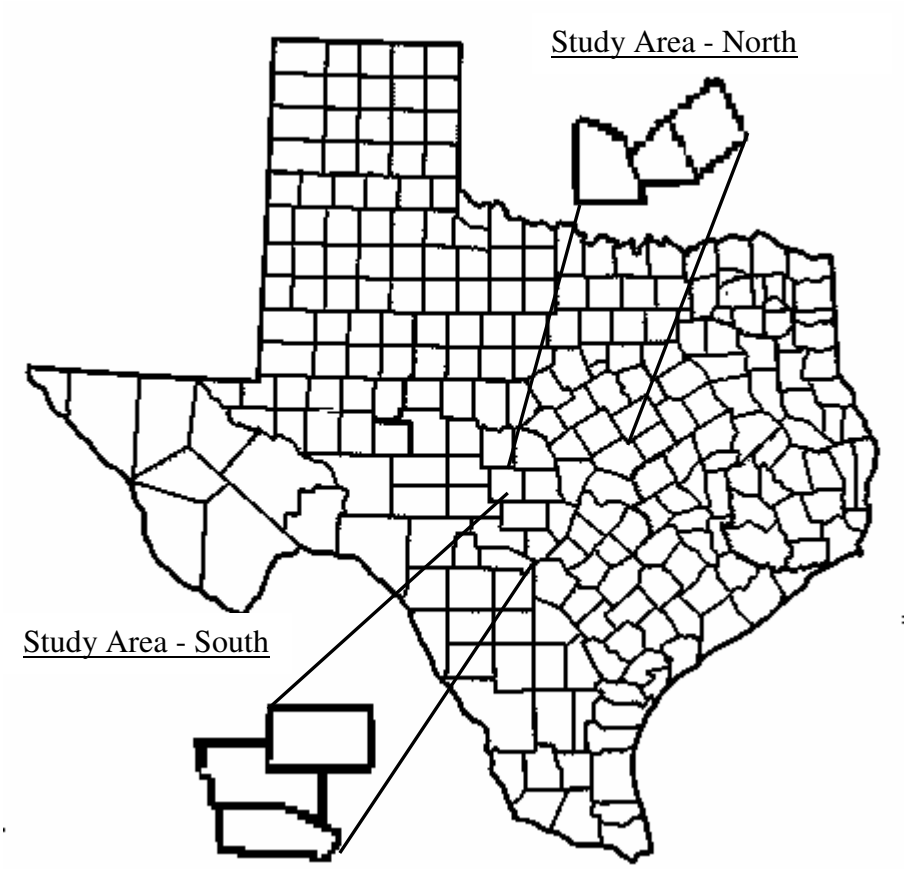

Figure 1. Map of Texas showing study area for this project.

In choosing the survey population, it was reasoned that the southern counties, located closer to San Antonio, were more likely to be experiencing land fragmentation and development pressure due to increased urban interest in rural land ownership. This is evidenced by statistics from the county appraisal lists. Overall, mean land ownership in these counties was 162.4 hectares, after owners with less than 16.2 ha (40 acres) were removed. Collectively, the three southern counties had more landowners with lower median and mean acreage than the three northern counties, as shown in Table 2.

Table 2. Appraisal list statistics of counties in sample population, grouped by region (* Coryell county did not respond to requests for an appraisal list).

		North		Regional	Overall
	Lampasas	San Saba	Coryell	Statistics	Statistics
# Landowners	1325.0	1369.0	NA*	2694.0	8578.0
Median size (ha)	75.7	80.6		78.5	69.4
Mean size (ha)	149.7	206.9		178.5	162.4
SE	7.3	12.2		4.0	3.6
95% CI	14.3	24.0		7.9	7.0
		South		Regional	
	Bandera	Kerr	Gillespie	Statistics	
# Landowners	1324.0	1641.0	2919.0	5884.0	
Median size (ha)	61.7	56.3	63.2	60.3	
Mean size (ha)	163.8	164.4	111.2	146.3	
SE	9.5	10.9	2.9	7.2	
95% CI	18.6	21.3	5.8	14.2	

Landowner Selection

In order to study landowner perceptions of wildlife management, landowner associations, and groundwater issues, a population of 600 Edwards Plateau landowners, each owning 16.2 ha (40 acres) or more, was selected for the survey. Landowners with smaller properties were eliminated because it was reasoned that they did not own

sufficient acreage to engage in management for wildlife habitat. To compile the survey population, membership lists were requested from Wildlife Management Associations (WMAs) across the Edwards Plateau. A total of 288 WMA members were randomly selected to be included in the study, 150 from the north and 138 from the south, out of 300 total landowners from each region (Table 3). Fewer southern members were selected because of the limited number of names received from southern WMAs.

Table 3. Survey sample shown by county and Wildlife Management Association (no WMAs were found in Kerr county, and Coryell county did not provide landowner data).

County	WMA	Members Contacted	Total # Members	Non-members Contacted (by county)	County and Region Totals
North Edwards Plateau					
Coryell	Plum Creek	25	27	0	50
	Vista Mountain	25	55		
Lampasas	Simms Creek	23	115	75	163
	Donalson Creek	19	19		
	Lucy Creek	23	42		
	SW Hamilton	23	68		
San Saba	Cherokee	12	12	75	87
	Total - North	150		150	300
South Edwards Plateau					
Bandera	CWLA	65	65	50	115
Gillespie	Cave Creek	51	52	50	123
	Cherry Spring	8	8		
	Doss	14	unknown		
Kerr				62	62
	Total - South	138		162	300
	Total	288		312	600

County landowner lists were requested from appraisal districts in these six counties (all but Coryell complied). In Bandera and Gillespie counties 50 non-member

landowners were randomly chosen. In Kerr County, 62 landowners were selected to make up for the lack of WMA members in the southern counties, and in San Saba and Lampasas counties, 75 names were chosen to make up for the failure of the Coryell county tax office to provide a landowner list. Half of the landowners from each county were selected from above and half from below the median property size for the study area (69.4 ha), to ensure a mixture of large and small landowners in the survey population and allow differences in management practices and attitudes between the two groups to be identified.

Mail Survey

Prior to administering the mail survey, attendees at a Wildlife Management Association field day in Hamilton, Texas on May 7, 2005 were informed of the nature of the project, and that they could potentially be part of the survey population. During this presentation, approximately 20 draft questionnaires were distributed for testing. Responses were used to refine the questionnaire and ensure clarity of the questions.

The final questionnaire was eight pages long, with a two-page supplement for completion by WMA members only (Appendix A). The survey questionnaire included questions on land management practices, opinions on wildlife and groundwater management issues, perceptions of cooperative resource management, measures of social capital, and demographics.

The study was conducted using the Dillman mail-survey method (Dillman, 2000), consisting of five contacts. Mailings were sent according to the following

schedule; a pre-survey letter was sent on June 13, followed one week later by the survey questionnaire and cover letter. On June 27, a reminder/thank you postcard was sent. These mailings were followed by a July 11 replacement survey and a July 25 reminder postcard, sent to those who had not responded to previous mailings.

Data Analysis

Response data were entered into a Microsoft Excel (Microsoft Corporation 2000) spreadsheet, and then exported to the Statistical Package for the Social Sciences (SPSS, Inc., release 12.0.0 2003).

Descriptive statistics were used to compare response rates to major variables such as management practices and association membership. Bivariate (t-test, crosstabs) and multivariate (ANOVA, Kruskal-Wallis, and factor analysis) analysis were used to compare landowner characteristics with respect to perceptions on land fragmentation, groundwater marketing, and cooperative resource management.

Analysis of variance results were used when more than two variables were compared and are presented by F-statistics and P-values. Bonferroni analysis was used to explore differences between specific variables in an ANOVA test, and P-values are reported. Kruskal-Wallis non-parametric test were also conducted for comparisons involving Likert-type scale results, and χ^2 and P-values are reported. For t-tests, which were used for pairwise comparison between survey groups, the t-statistics and p-values are given. Goodman and Kruskal's gamma statistic and associated p-value are reported for crosstabs results, which were used to analyze categorical data. Factor analysis was

used to examine relationships between responses to survey questions, for the purpose of reducing related variables into overarching indices. Cronbach's alpha, an indicator of how reliably a set of items can be treated as measuring a single variable, is reported, as well as rotated component matrix scores for each variable in the resulting index.

CHAPTER IV

RESPONDENT CHARACTERISTICS

Supplemental information for the results reported in this section can be found in Appendices B and F.

Of the 594 landowners who were successfully contacted (six surveys were returned to sender), 286 completed and returned the survey questionnaire, for a response rate of 48.1%. WMA members made up 59.4% of respondents, while non-members made up the remaining 40.6%. Of the 288 WMA members surveyed, 153 responded (53.1%). Furthermore, 17 respondents taken from appraisal lists happened to be members of WMAs. Of the 312 non-members surveyed, 115 actual non-members responded. Analyzed by WMA membership and land size, members with whose properties were greater than the survey population median property size (69.4 ha) made up the largest group (n= 87) (Table 4). Response rates for north (45.8%) and south (46.2%) regions were nearly identical, and are presented in Table 5.

Table 4. Respondents categorized by WMA membership and land size (*NR denotes respondents that did not provide information for either of the two variables used in table).

	Member		Non-member		Total	
Land Size	Freq.	Percent	Freq.	Percent	Freq.	Percent
Small	75	26.2	60	20.0	135	47.2
Large	87	30.4	54	18.9	141	49.3
NR*					10	3.5
Total	162	56.6	114	38.9	286	100

Table 5. Survey response rates categorized by region (*NR denotes respondents that live outside the two survey regions and thus were excluded from regional analyses).

	Member		Non-member		Total	
Region	Freq.	Percent	Freq.	Percent	Freq.	Percent
North	80	51.6	50	46.7	130	45.5
South	75	48.4	57	53.3	132	46.1
Other/NR*					24	8.4
Total	155	100	107	100	286	100

Property sizes of respondents ranged from 16 to 3,734 hectares, with a median of 131.5 ha and a mean of 290.1 ha. This median value was used to divide the respondents into equal large and small property size groups. There was no significant difference between members and non-members ($t= 2.214$; $P= 0.053$) or northern and southern groups ($t=-0.715$; $P=0.475$) with respect to property size. Mean period of land ownership was 50.6 years, and there was no significant difference between WMA members and non-members ($t= 1.705$; $P= 0.089$). However, on average, large-property landowners ($t= -4.727$; $P< 0.001$) and southern owners ($t=-2.500$; $P= 0.013$) have owned their land for significantly longer than their small-property and northern counterparts (Fig. 2). Average age of respondents was 62, ranging from 28 to 95 years of age. There were no significant age differences between any groups (membership $t= 0.131$, $P= 0.896$; land size $t= 0.900$, $P=0.369$; region $t= -0.553$, $P= 0.581$).

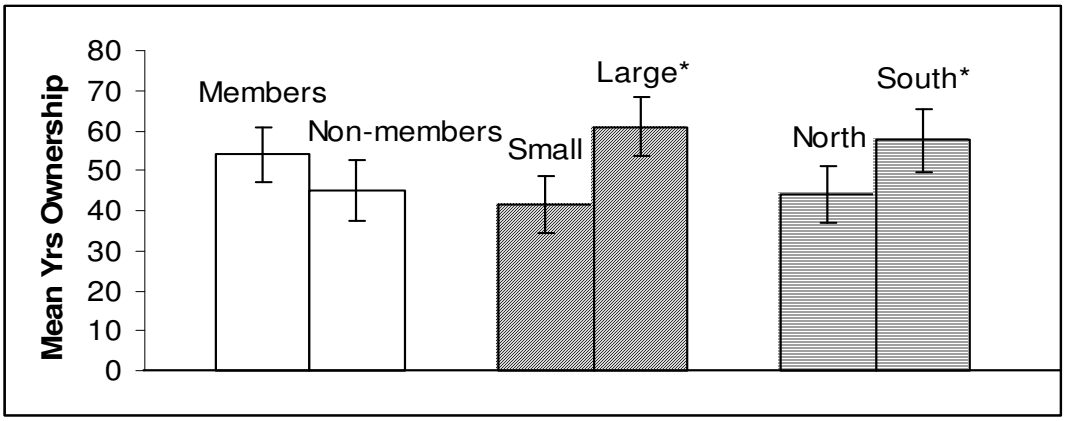

Figure 2. Mean years of land ownership of WMA membership, land size, and region groups (*denotes significant differences between paired groups, error bars show 95% CI).

When asked about their occupation, the largest proportion of respondents indicated they were retired (29.2%), followed closely by professional (28.0%) and agriculture (25.1%) (Fig. 3). Crosstabs analysis shows significant differences between large and small landowners in occupation (γ= -0.430, P< 0.001). The biggest differences were in the percentages of those who claimed agriculture (small = 11.9%, large = 33.8%) and retired (small = 33.8%, large = 19.0%) (Table 6). There were no significant occupational differences between membership (γ= 0.129, P= 0.140) or region (γ = -0.065, P= 0.479) groups.

Income of respondents was analyzed, and 25.9% earned between $75,000 and $100,000, while 21.7% earn between $25,000 and $50,000 per year (Table 7). There were no significant differences in income between WMA members and non-members (γ= 0.015; P= 0.870), large- and small-property owners (γ= 0.146, P= 0.133) or northern and southern respondents (γ= 0.017; P= 0.854).

Figure 3. Occupation of survey respondents.

Table 6. Occupation of survey respondents classified by land size (* denotes significant difference between occupations).

	Small (<131.5 ha)		Large (>131.5 ha)	
Occupation	Frequency	Percent	Frequency	Percent
Agriculture*	17	11.9	48	33.8
Professional	34	23.9	41	28.9
Service	8	5.6	3	2.1
Homemaker	5	3.5	2	1.4
Retired*	48	33.8	27	19.0
Business Owner	12	8.4	7	4.9
Other	7	4.9	3	2.1
No response	12	8.4	12	8.4
Total	143	100	143	100

Table 7. Total income of survey participants.

Total Income	Frequency	Percent
Less than $25,000	18	6.3
$25,001-$50,000	62	21.7
$50,001-$75,000	54	18.9
$75,001-$100,000	74	25.9
More than $100,000	53	18.5
No Response	25	8.7
Total	286	100

WMA members (t= 3.405, P= 0.001) and large landowners (t= -6.638, P< 0.001) reported earning a greater percentage of their income from their land than their counterparts (Fig. 4). There was no regional difference in income from property-related activities (t=-1.871, P= 0.063).

In addition, large landowners made a significantly larger share of their property income from fee hunting than did small owners (t= -2.243; P= 0.026), and southern owners also earned a greater proportion from fee hunting than northern owners (t= -2.605; P= 0.010) (Fig. 5).

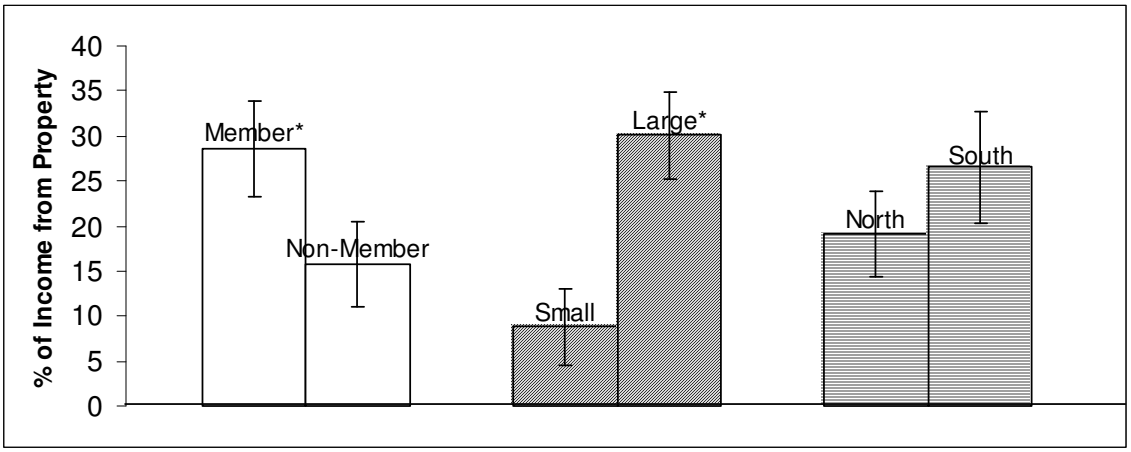

Figure 4. Percent of income from property of survey groups (* denotes significant difference between paired groups, error bars show 95% CI).

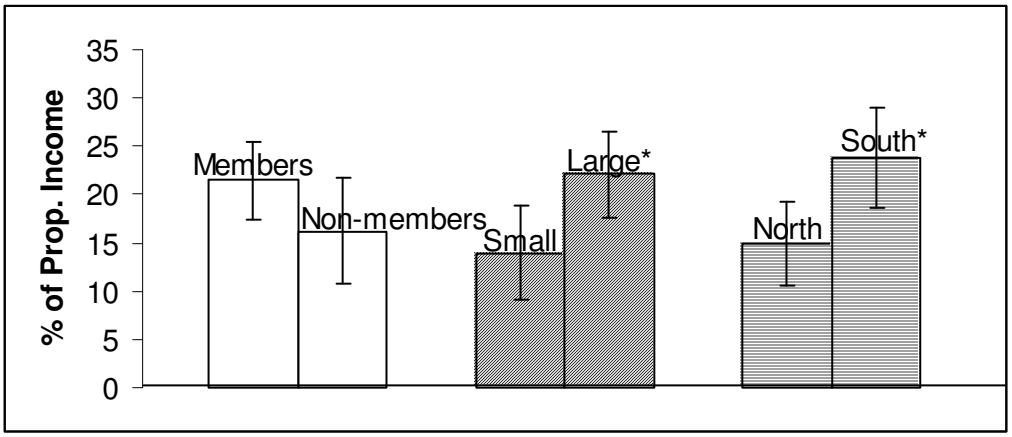

Figure 5. Percent of property income from fee hunting of survey groups (*denotes significant differences between paired groups, error bars show 95% CI).

An analysis of education of survey respondents found no significant differences between survey groups. A large majority (74.1%) of respondents attended at least some college, and only 2.8% did not finish high school. Education level of respondents is presented in Figure 6.

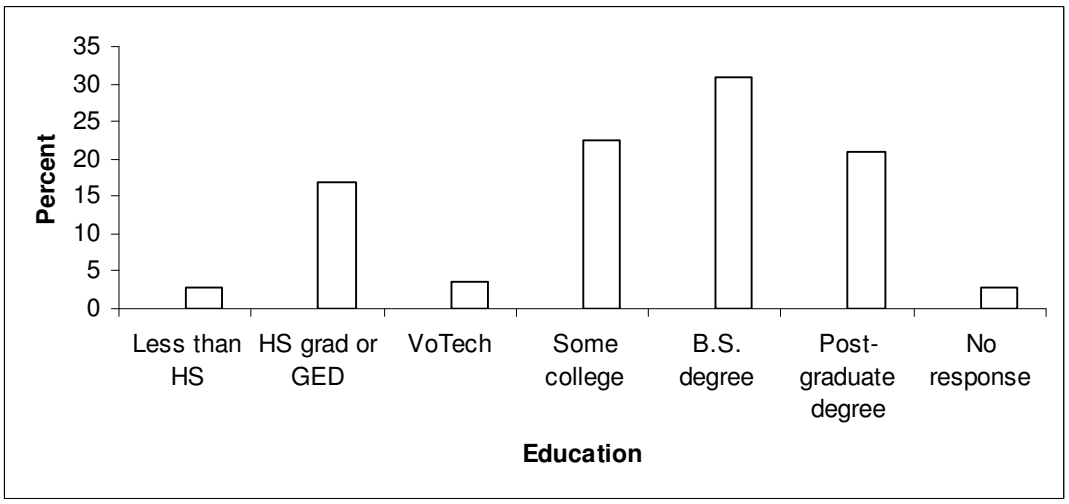

Figure 6. Education level of survey respondents.

When survey participants were asked about their primary residence, 56.3% said they live on their property (Fig. 7). A higher proportion of WMA members live on their property than non-members ($t = -3.620$, $P < 0.001$).

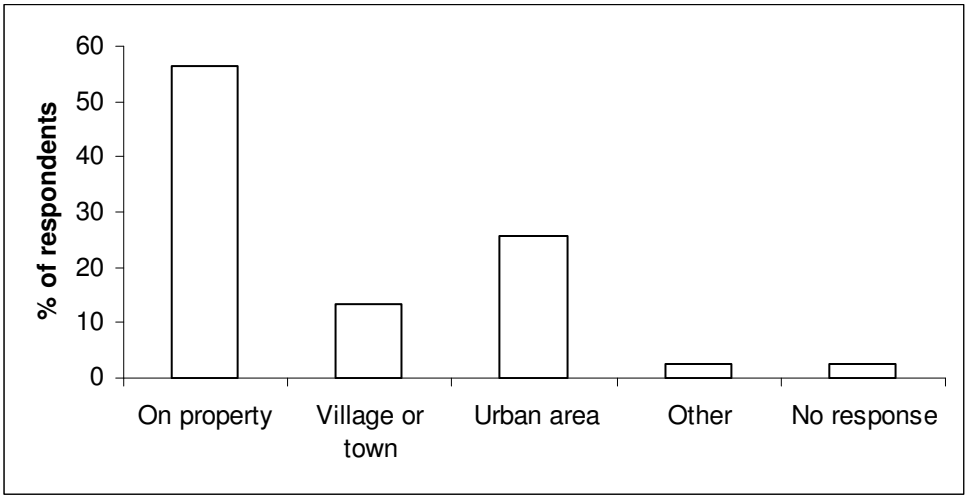

Figure 7. Primary residence of survey respondents.

Survey participants were asked to use a 7-point Likert-type scale to rate the importance of each of 12 land use priorities, and "scenic beauty" received the highest mean ratings (Table 8), followed by "wildlife management" and "relaxation/leisure." This suggests that, overall, respondents to this survey value their land for enjoyment more than for production. "Development" received a strongly negative score, suggesting that respondents value their property, want to keep it rural, and are unlikely to sell it.

Table 8. Importance of land use priorities of survey respondents (+3= very important…-3= not important at all).

Priority	Mean Response Value	SE	95% CI
Scenic Beauty	2.37	0.06	0.12
Wildlife	2.25	0.07	0.14
Relax/Leisure	2.24	0.07	0.13
Livestock	2.01	0.10	0.20
Place to Live	2.01	0.10	0.20
Investment	1.46	0.11	0.22
Lease Hunting	0.58	0.14	0.27
Non-lease Hunting	0.56	0.12	0.24
Farming	0.48	0.14	0.27
Tourism/Recreation	-0.17	0.13	0.25
Minerals	-1.16	0.12	0.23
Development	-2.08	0.10	0.19

WMA members (t= 2.045, P= 0.042; χ^2= 6.057, P= 0.014), large landowners (t= 0.398, P< 0.001; χ^2= 29.831, P< 0.001), and southern landowners (t= 0.379, P= 0.011; χ^2= 6.665, P= 0.010) all indicated that "lease hunting" was more important to them than their counterparts (Fig. 8). These three groups also rated "wildlife management" higher than their counterparts (membership t=3.925, P< 0.001, χ^2= 20.074, P< 0.001; land size t=-1.977, P=0.049, χ^2= 3.122, P= 0.077; region t=-2.398, P=0.017, χ^2= 2.953, P= 0.086). Members rated "commercial/residential development" lower (t=-2.535, P= 0.007; χ^2= 5.123, P= 0.024) than non-members. Large landowners gave "farming/hay production" (t=-2.460, P= 0.015; χ^2= 15.467, P< 0.001) and "livestock production" (t=-3.466, P< 0.001; χ^2= 23.823, P< 0.001) a higher mean response than small landowners.

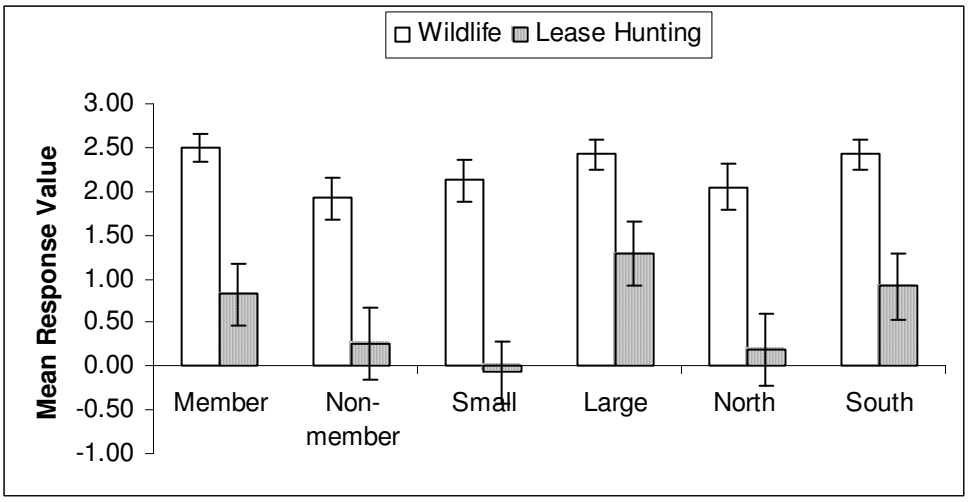

Figure 8. Importance to survey groups of wildlife and lease hunting as land use priorities (+3= very important…-3= not important at all, all comparisons significant, error bars show 95% CI).

CHAPTER V

RESPONDENT PERCEPTIONS AND MANAGEMENT PRACTICES

Supplemental information for the results reported in this section can be found in Appendices B through G.

Survey participants were asked several questions about management practices on their land. They were then asked to give their opinion on a series of rangeland management and groundwater issues by using a Likert-type scale of +3 to -3 (+3= very favorable…-3= very unfavorable). Statements in both lists touched on philosophy, government involvement, and cooperative versus autonomous decision-making. Survey participants were also asked about reasons for not joining landowner management associations and about civic participation.

Rangeland Management

Survey participants were given a list of land management activities and asked for the approximate number of acres on which each practice was used in the previous three years. This information, along with the total acreage owned by each landowner, was used to calculate the percentage of each respondent's land on which each practice was used. These results were then compared between survey groups. "Rotational grazing" and "mechanical or chemical brush control" were the most commonly used management practices. No other listed activity, on average, was applied to more than 10% of respondents' properties.

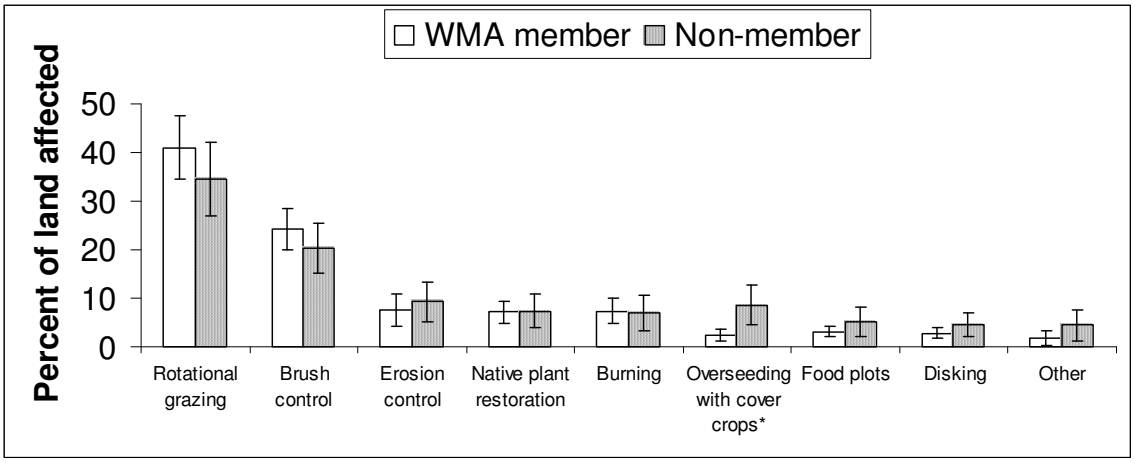

Figure 9. Mean proportion (%) of WMA members' and non-members' land on which certain management practices were used during the last three years (* denotes significant difference, error bars show 95% CI).

"Overseeding improved pasture with winter cover crops" was practiced on significantly more acres by non-members, who overseeded on 8.63% of their land compared to only 2.5% of members' land (t= -2.826, P= 0.005) (Fig. 9). Small-property owners performed more "disking to produce wildlife foods" (t= 2.623, P= 0.009) and "wildlife food plots" than large-property owners (t= 2.938, P= 0.004). Conversely, large-property owners performed more rotational grazing than small owners (t= -3.207, P= 0.002), while northern landowners disked significantly more acres than southern owners (t= 3.088, P= 0.002).

Survey participants were questioned on their use of government conservation programs. A list of seven programs was presented, and landowners were given three options to characterize their level of use of each; "am currently", "have in the past", and "never". These responses received scores from two (am currently) to zero (never). The Environmental Quality Incentives Program (EQIP) was the only one that was widely

used, with a mean score of 1.67. No other program received a score greater than 0.13 (Table 9).

Table 9. Use of government programs by survey participants (2 = "am currently using"…0 = "never used").

Program	Mean Response Value	SE	95% CI
EQIP	1.67	0.04	0.08
CRP	0.13	0.03	0.06
Other	0.12	0.04	0.08
LIP	0.07	0.02	0.04
WHIP	0.06	0.02	0.04
Partners for Wildlife	0.02	0.01	0.02
WRP	0.01	0.01	0.02
PUB	0.00	0.00	0.00

Each respondent's scores for each program were summed to give a government program index value. This value was used to compare the different survey groups. There were no significant differences between any groups (membership t= 0.105, P= 0.509, land size t= -0.013, P= 0.990, region t= -0.919, P= 0.359). The low use of government programs among all respondents likely accounts for the lack of significant differences between groups.

Landowners were asked about their use of a series of wildlife management actions, specifically deer harvest and management, pest control, and provision of shelter. They were asked to indicate the number of times they used each practice in the previous three years (Table 10). Available options were 0, 1, 2, 3, and 3+. The most commonly used practice was "selective buck harvest", followed by "update deer harvest records".

Even the least commonly used actions, “fire ant control” and “feral hog control”, were used more than once in the previous three years by respondents as a whole.

Table 10. Survey participants’ use of wildlife management actions (number of times in the last three years).

Action	Mean Response Value	SE	95% CI
Selective buck harvest	2.21	0.11	0.22
Update deer harvest records	2.08	0.11	0.22
Selective doe harvest	2.03	0.11	0.22
Deer counts	1.93	0.11	0.22
Deer Index	**2.09**	**0.09**	**0.18**
Coyote control	1.54	0.11	0.22
Provide supplemental shelter	1.42	0.11	0.22
Fire ant control	1.38	0.11	0.22
Feral hog control	1.24	0.11	0.22

The four deer-related practices were found by factor analysis to be related (Cronbach’s alpha = 0.859, rotated component matrix scores: 0.758, 0.896, 0.886, 0.880), and were averaged into a deer index. Scores on this index were compared between survey groups. Members ($t= 8.852$, $P< 0.001$) and large owners ($t= -3.614$, $P< 0.001$) scored significantly higher than their counterparts, while there was no difference between the two region groups ($t= 0.364$, $P= 0.716$) (Fig. 10).

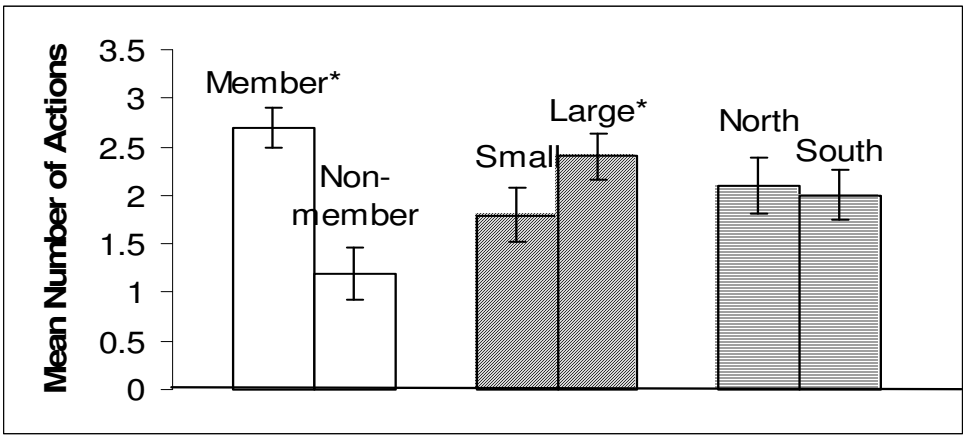

Figure 10. Scores of survey groups on index of deer-related wildlife management actions (*denotes significant difference between paired groups, error bars show 95% CI).

Members also performed more "coyote control" (t= 5.215, P< 0.001) and scored higher on "provide supplemental shelter" (t= 3.453, P< 0.001). Large owners performed more coyote (t= -5.600, P< 0.0010) and feral hog (t= -4.986, P< 0.001) control, as did southern owners (t= -2.196, P= 0.029) (t= -2.806, P= 0.005).

In section B of the survey questionnaire, survey participants were asked their opinions on a series of wildlife management issues. Respondents were most favorably disposed to the "control of woody plants to improve wildlife habitat", followed by "free movement of native wildlife across the landscape and "autonomous decision making authority by landowners about native wildlife management on their land" (Table 11). In contrast, respondents were least favorable towards the statements "public owns native wildlife on private land" and "high fencing to restrict the movement of wildlife." It is noteworthy that public ownership of wildlife received the same mean response as high fencing to restrict wildlife, since high fencing effectively gives private landowners ownership of wildlife within their fences. Landowners apparently did not see any

connection between the free movement of native wildlife, which received a high favorable response, and public ownership of native wildlife, which received an unfavorable response.

Table 11. Respondents' opinions of wildlife management issues (+3= very favorable… -3= very unfavorable).

Issue	Mean Response Value	SE	95% CI
Woody plant control for wildlife habitat	2.10	0.08	0.16
Free movement of wildlife	1.68	0.11	0.22
Autonomous decision-making	1.68	0.10	0.20
Assistance with wildlife management plans	1.62	0.09	0.18
WMA's for wildlife management	1.49	0.11	0.22
Use of fire for wildlife habitat	1.43	0.10	0.20
Opinion of TPWD	1.37	0.10	0.20
Cost-sharing for wildlife habitat	1.26	0.10	0.20
Joint decision-making	1.16	0.11	0.22
Opinion of NRCS	0.68	0.11	0.22
Opinion of USFWS	0.46	0.11	0.22
Improving endangered species habitat	0.32	0.12	0.24
Opinion of NGO's	-0.32	0.12	0.24
Conservation easements	-0.55	0.12	0.24
Public ownership of wildlife	-0.93	0.15	0.30
High fencing to restrict wildlife	-0.96	0.13	0.26

Wildlife Management Association members had more favorable opinions than non-members on the "use of fire to improve wildlife habitat" ($t= 2.728$, $P= 0.007$; $\chi^2= 6.003$, $P= 0.014$), "joint decision-making by neighboring landowners about native

wildlife management on their land" (t= 2.825, P= 0.005; χ^2= 9.096, P= 0.003), and "Wildlife Management Associations as a vehicle for coordinated wildlife management" (t= 5.891, P< 0.001; χ^2= 42.100, P< 0.001) (Fig. 11).

Small and large landowners had similar opinions on the question of movement of wildlife vs. high fencing, but to significantly different degrees. While both groups were unfavorable toward public ownership of native wildlife, small owners were less so (t= 2.158, P= 0.032; χ^2= 4.063, P= 0.044). Small owners were more favorable to the free movement of native wildlife (t= 3.185, P= 0.002; χ^2= 7.594, P= 0.006), but less favorable to the idea of using high fences to restrict (t= -3.289, P= 0.001; χ^2= 10.890, P= 0.001) (Fig. 12). This seems to agree with results in the previous chapter showing that large landowners make a larger percentage of their income from lease hunting, and consider lease hunting a higher priority.

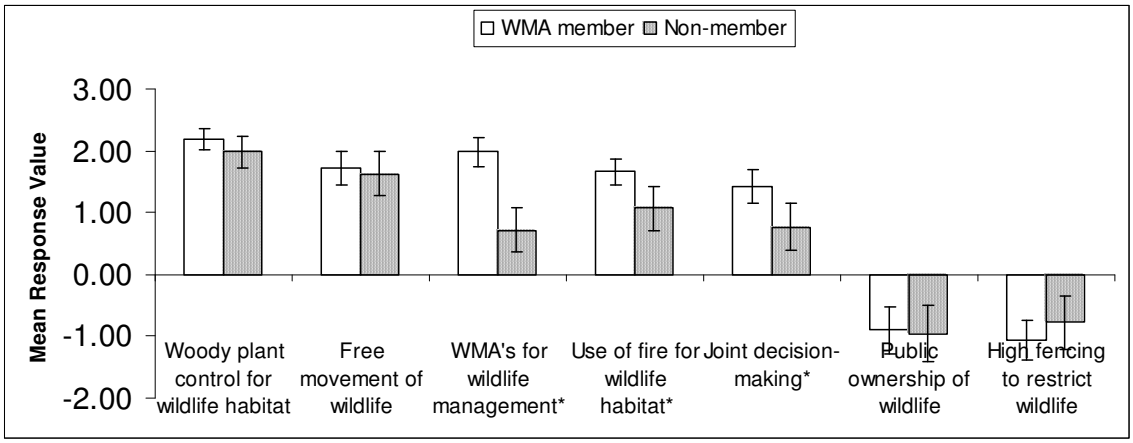

Figure 11. Members' and non-members' opinions on selected wildlife management issues (+3= very favorable…-3= very unfavorable, *denotes significant difference, error bars show 95% CI).

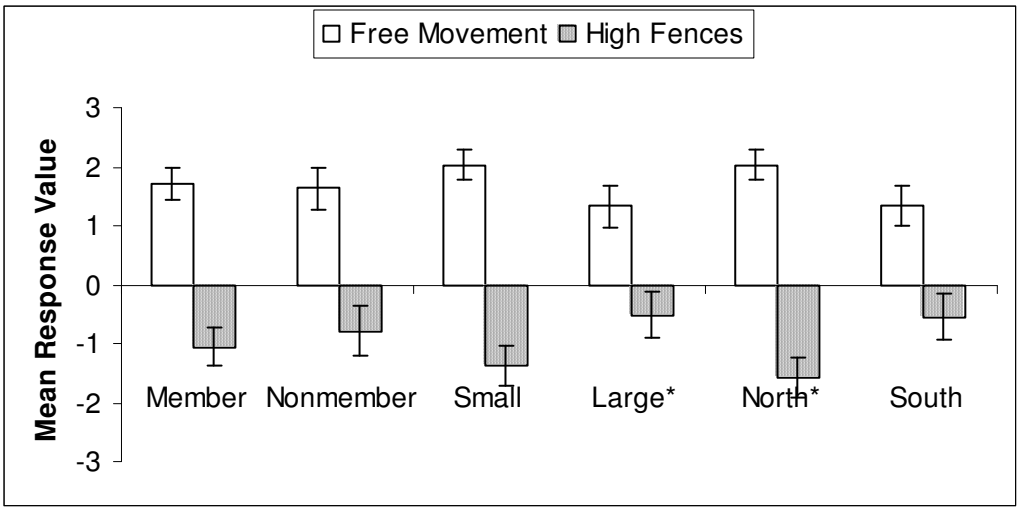

Figure 12. Opinions of survey groups on free movement of native wildlife and high fences to restrict movement of wildlife (+3= very favorable…-3= very favorable, * denotes significant differences for both statements, error bars show 95% CI).

Other differences were found between small and large landowners. Small landowners had a more favorable opinion of "improvement of endangered species habitat" (t= 3.140, P= 0.002; χ^2= 11.473, P= 0.001) and of "the US Fish and Wildlife Service" (USFWS) (t= 2.353, P= 0.019; χ^2= 5.177, P= 0.023). These results are related in that it is the USFWS that administers the Endangered Species Act. Large landowners were more favorable towards the use of fire (t= -2.605, P= 0.010; χ^2= 8.374, P= 0.004) but less favorable towards "non-government organizations (e.g., Nature Conservancy)" (t= 2.271, P= 0.024; χ^2= 5.272, P= 0.022).

There were also regional differences on the question of free movement vs. high fences similar to those seen between large and small landowners. Both northern and southern groups were favorably disposed to free movement of native wildlife and unfavorable towards high fences to restrict wildlife, but northern owners were

significantly more in favor of free movement (t= 3.102, P= 0.002; χ^2= 8.788, P= 0.003) and more opposed to high fences (t= -3.875, P< 0.000; χ^2= 15.155, P< 0.001) (Fig. 11). Northern owners were also more favorable towards "Texas Parks & Wildlife Department" and WMA's (t= 2.563, P= 0.011; χ^2= 4.595, P= 0.032). Southern owners were more favorable towards the use of fire (t= -2.600, P=0.010; χ^2= 8.062, P= 0.005).

Groundwater Management

Respondents were asked how often in the previous three years they had performed each of a list of eight water conservation actions. Available responses were 0 to 3+, similar to the question on wildlife management actions. "Woody plant control for increased water infiltration" was the most common practice, with a mean of 1.32. No other action received a mean response of over 1 (Table 12).

Table 12. Respondents' level of use of water conservation actions in previous three years (number of times).

Action	Mean Response Value	SE	95% CI
Woody plant control	1.32	0.10	0.20
Pond construction	0.91	0.09	0.18
Terracing	0.63	0.08	0.16
Shape waterways	0.56	0.07	0.14
Rainwater harvesting	0.56	0.08	0.16
Reseed with native plants	0.53	0.07	0.14
Improve streamside buffers	0.42	0.07	0.14
Exclude livestock from streamsides	0.38	0.07	0.14

Members performed two practices more than non-members: terracing (t= 2.510, P= 0.013) and woody plant control (t= 3.102, P= 0.002) (Fig. 13). Large owners differed from small owners by doing more terracing (t= -2.273, P= 0.024), streamside buffers (t= -2.579, P= 0.011), native plant reseeding (t= -2.118, P= 0.035), and woody plant control (t= -3.063, P= 0.002). Southern owners reported more livestock exclusion from streamsides (t= -2.199, P= 0.029) and woody plant control (t= -2.374, P= 0.018).

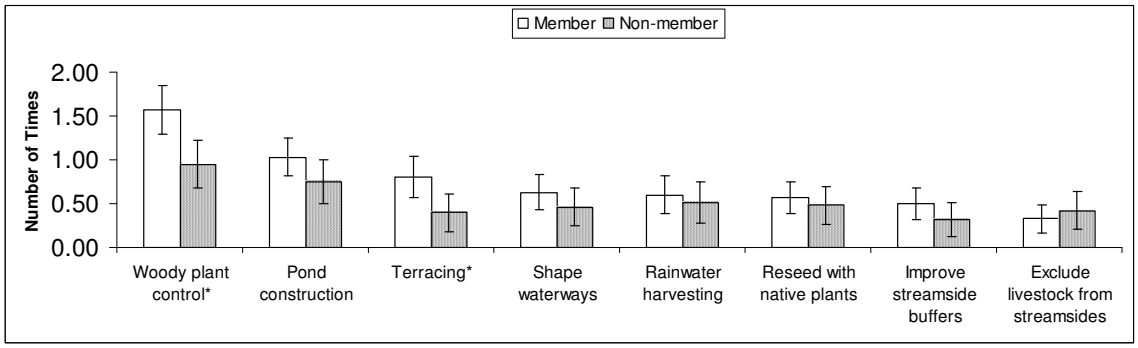

Figure 13. WMA members' and non-members' use of water conservation actions in previous three years (* denotes significant differences, error bars show 95% CI).

Next, participants were asked for their opinions on a series of groundwater management questions. "The 'rule of capture' for groundwater in Texas" received the highest positive response, followed by "groundwater pumping based on sustainable aquifer yield" and "evaluating ecological impacts of groundwater transfers." "Federal government oversight of groundwater issues", "the transfer of groundwater from rural to urban areas" and "the purchase and sale of groundwater in general" all received strong negative responses. It is clear that landowners are opposed to government oversight of groundwater issues, and the farther removed the government is, the higher the

opposition. Conversely, it is also apparent that landowners are not ready to trust the allocation of groundwater to the free market. Responses to all groundwater questions are shown in Table 13.

The different survey groups that were questioned were in agreement on nearly every groundwater question. The only significant differences were that large-property owners had a more favorable opinion of the "rule of capture" (t= -1.976, P= 0.049; χ^2= 4.150, P= 0.042), and that northern owners had a more unfavorable opinion towards the purchase and sale of groundwater (t= -1.986, P= 0.048; χ^2= 4.233, P= 0.040).

Table 13. Landowner response when asked "What is your opinion regarding each of the following groundwater management issues?" (+3= very favorable…-3 = very unfavorable).

Issue	Mean Response Value	SE	95% CI
Rule of capture	1.38	0.13	0.26
Pumping based on sustainable yield	0.70	0.13	0.26
Evaluating ecological impacts of transfers	0.70	0.13	0.26
Formation of groundwater conservation districts	0.38	0.13	0.26
Evaluating socio-economic impacts of transfers	0.37	0.13	0.26
Groundwater permit system	-0.13	0.15	0.30
Local government oversight	-0.19	0.14	0.28
Your right to buy/sell groundwater	-0.56	0.14	0.28
Neighbor's right to buy/sell groundwater	-0.65	0.14	0.28
State government oversight	-0.98	0.12	0.24
Private groundwater cooperatives for marketing	-1.15	0.12	0.24
Purchase and sale of groundwater	-1.33	0.12	0.24
Transfer of groundwater from rural to urban	-1.76	0.11	0.22
Federal government oversight	-1.94	0.10	0.20

Association Membership

In section C, respondents who indicated they were not members of a Wildlife Management Association were asked to rate the importance of a list of potential reasons for not joining. The reason that received the highest response was "don't want to give up control of my land", followed by "don't see any economic benefit to being a member". "Want a high fence around my own property" was the least important reason. Responses are shown in Figure 14.

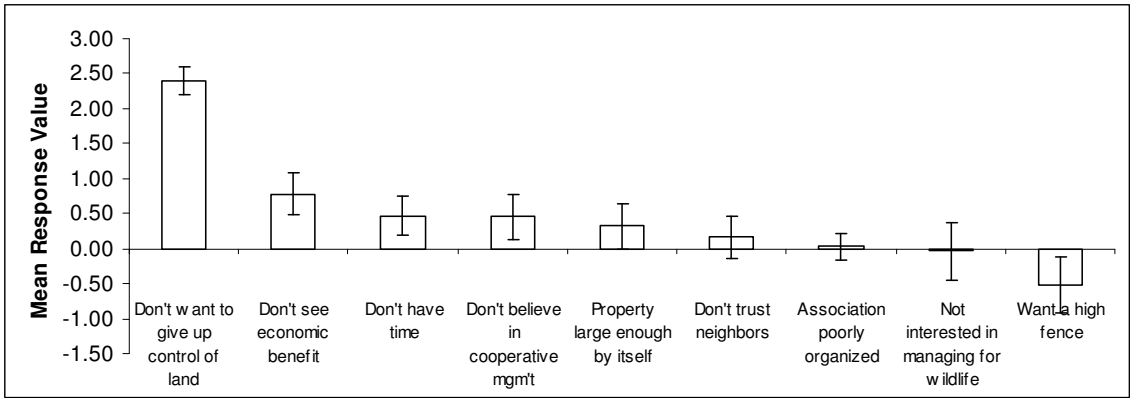

Figure 14. Landowner response to the question "How important is each of the following reasons for not joining a Wildlife Management Association?" (+3= very important…-3= not at all important, error bars show 95% CI).

Survey participants were next asked about their likelihood of joining a Groundwater Marketing Association if it existed in their area. Landowners from all groups showed little interest in joining such an Association. Only 17.5% indicated that they were "very likely" or would "possibly" join, while 35.6% were "uncertain" and 46.9% said they were "unlikely" or "very unlikely" to join (Fig. 15). The substantial proportion of respondents that indicated uncertainty about joining Groundwater

Marketing Associations suggests that an educational campaign could potentially persuade a large number of landowners to join such an association.

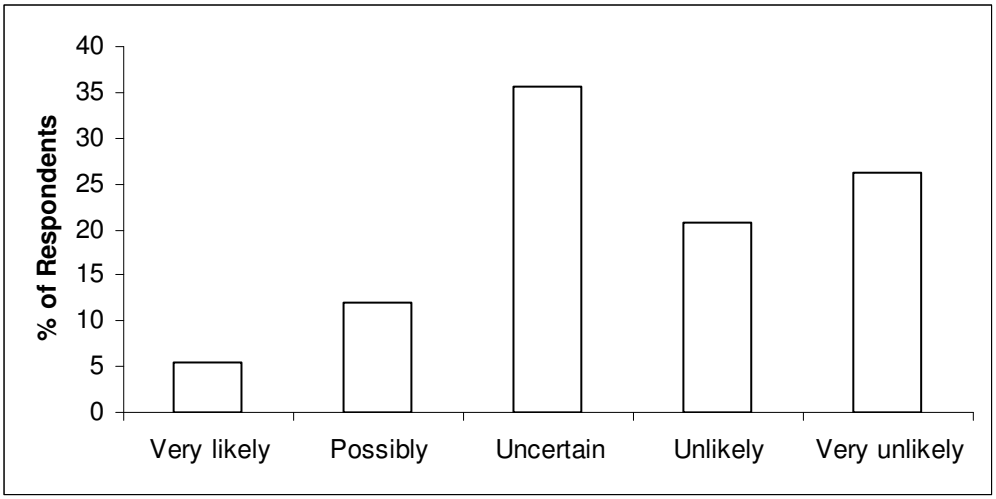

Figure 15. Landowner response to "If a Groundwater Marketing Association were to exist in your area how likely would you be to become a member?"

All participants were asked to rate a list of possible reasons for not joining a Groundwater Marketing Association. "Am not interested in selling groundwater" was the most popular reason, followed by "don't think it is ethical to sell groundwater for profit". All of the other listed reasons received scores between 0 and 1, which indicates slight agreement (Table 14).

Table 14. Landowner response to "How strongly do you agree with each of the following possible reasons for not joining a Groundwater Management Association?" (+3= strongly agree…-3= strongly disagree).

Reason	Mean Response Value	SE	95% CI
Not interested in selling groundwater	1.56	0.11	0.22
Don't think it's ethical	1.05	0.12	0.24
Don't think joint marketing can work	0.59	0.10	0.20
Disagreement Index	**1.07**	**0.09**	**0.18**
Don't want to limit my groundwater extraction	0.86	0.11	0.22
Don't trust other members to comply	0.61	0.10	0.20
Don't think there is economic benefit	0.47	0.09	0.18
Don't have time or interest to join	0.31	0.10	0.20
Don't believe in cooperative mgm't	0.12	0.11	0.22

Factor analysis was performed on the results of this question, and the responses to "not interested in selling groundwater" and "don't think it is ethical" were combined into a disagreement index with "don't think that joint groundwater marketing can work" (Cronbach's alpha = 0.857; rotated component matrix scores: 0.871, 0.828, 0.635). WMA members scored significantly higher on this index than non-members (t= 2.075, P= 0.039; χ^2= 5.782, P= 0.016). This suggests that, contrary to our hypothesis, WMA members appear to be less interested than non-members in coordinated groundwater

marketing. It appears that this difference has both ethical and skeptical components. What is more interesting, and contrary to expectations, is that members also gave a significantly more agreeable response to "don't trust other members of an Association to comply with water withdrawal agreements" (t= 2.118, P= 0.035; χ^2= 9.096, P= 0.003). This implies that people who are members of a WMA might not be more likely than non-members to trust members of another type of association to comply with that association's rules. Thus, while members may trust others in their association, they don't necessarily trust the general public. There were no differences between land size (t= 0.125, P= 0.901; χ^2= 2.830, P= 0.093) or region (t= -0.860, P= 0.391; χ^2= 0.429, P= 0.513) on the disagreement index (Fig. 16).

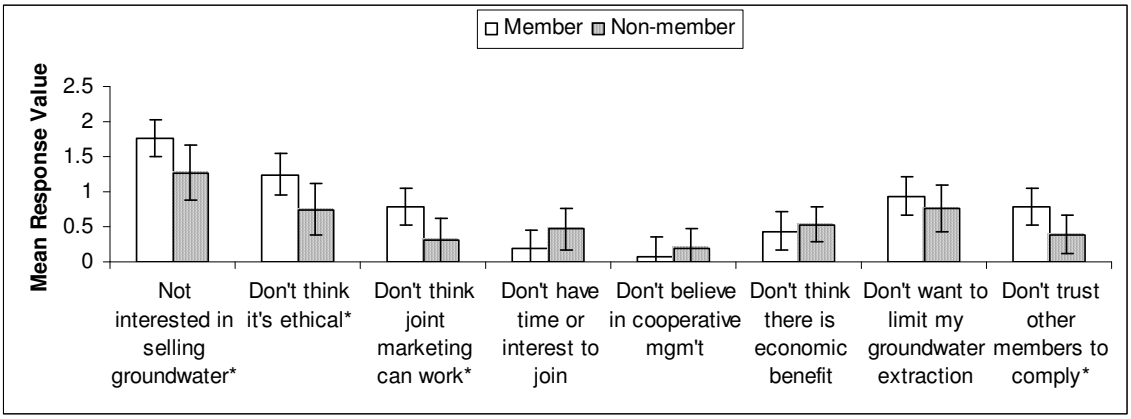

Figure 16. Members' and non-members' response to "How strongly do you agree with each of the following possible reasons for not joining a Groundwater Management Association?" (+3= strongly agree…-3= strongly disagree, *denotes significant differences, error bars show 95%CI).

Social Capital

In section D of the questionnaire, participants were asked a series of questions about involvement in community and natural resource organizations, and also about trust and cooperation. First, 7 types of community organizations were listed, and participants were asked to indicate whether they were very, somewhat, or not involved. Each answer choice was given a numerical score (very = 2, somewhat = 1, not = 0), and the scores for each respondent was summed, with possible "community involvement" scores ranging from 0 to 16. The mean score for this question was 4.68, with a median and mode of 4. WMA members scored higher than non-members ($t= 2.862$, $P= 0.005$), and large-property owners scored higher than small-property landowners ($t= -4.302$, $P<0.001$). There was no significant difference between northern and southern landowners ($t= -0.981$, $P= 0.327$). This tells us that WMA members and large landowners are more involved in community organizations than their counterparts (Fig. 17).

Among individual types of organizations, participation in "church groups" was most commonly cited, with a mean of 1.22, followed by "ranch/farm organizations" and "other".

Survey participants were also presented with a list of 16 natural resource organizations, and asked to check those of which they were members. Results show that the respondents were in an average of 1.18 such organizations. The largest proportion (36.4%) indicated they were not members of any natural resource organizations, and only 11.9% claimed membership in three or more (Table 15).

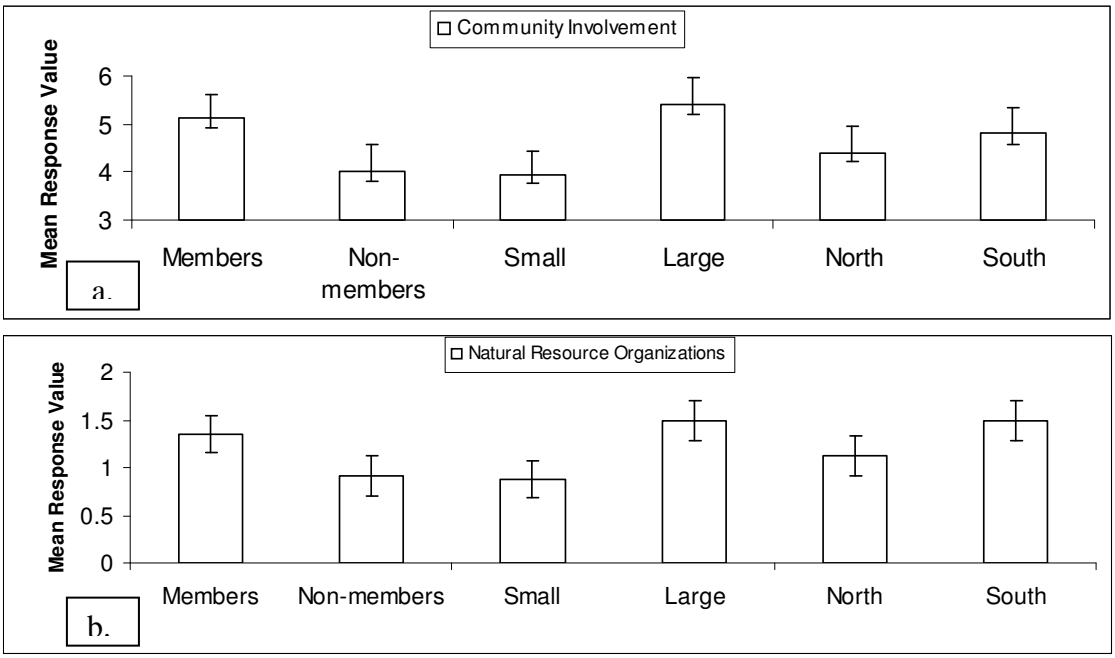

Figure 17. Membership of survey groups in (a) community and (b) natural resource organizations.

Table 15. Membership of landowners in natural resource organizations.

Number of Organizations	Number of Respondents	Percent of Total
0	104	36.4
1	78	27.3
2	70	24.5
3	25	8.7
4	5	1.7
5	1	0.3
6	1	0.3
7	2	0.7
Total	286	100

Comparison between survey groups on this question showed results similar to the above comparison of involvement in community organizations. WMA members were involved in more organizations than non-members ($t= 3.017$, $P= 0.003$), and large

landowners were involved in more than small landowners (t= -4.204, P= 0.000). Again, there was no difference between northern and southern groups (t= -1.095, P= 0.274) (Fig. 17).

Among natural resource organizations, Texas Farm Bureau had the most members, with 45% of respondents claiming membership, followed by Soil and Water Conservation Districts (18%) and the Texas Wildlife Association (17%).

Next, the survey participants were asked to rate their level of agreement with a series of ten statements about trust and cooperation. Four of the statements were designed to serve as an index to measure trust, and three were designed as an index for reciprocity, both of which are indicators of social capital. By using these indices, comparisons of social capital levels between survey groups can be made. The four trust statements were "I know most of the people in the area that I live", "I often socialize with landowners in my area", "I consider many people in the area that I live to be friends", and "I trust the people in the area that I live". Factor analysis found these statements to be related (Cronbach's alpha = 0.850; rotated component matrix scores: 0.810, 0.797, 0.857, 0.729), and they were combined into a trust index.

The three reciprocity statements were "I would provide time to help non-kin landowners in my area", "I would loan equipment to non-kin landowners in my area", and "I lend money to non-kin landowners in my area". Factor analysis found that only the second and third statements were related (Cronbach's alpha = 0.850; rotated component matrix scores: 0.836, 0.801), so the first statement was removed from the reciprocity index.

Two of the trust statements received the highest scores, with "I trust the people in the area that I live" having a mean of 1.61 and "I consider many people in the area that I live to be friends" having a mean of 1.55. "I would provide time to help non-kin landowners in my area" also received a mean value of 1.55. Two statements, asking whether most landowners would voluntarily comply with land conservation practices and deer hunting guidelines if urged to do so by leading landowners, received tepid agreement, with means of 0.42 and 0.61, respectively. "I would lend money to non-kin landowners in my area" received the most negative response (mean= -1.15), and was the only statement with which respondents disagreed as a whole (Table 16).

WMA members scored higher than non-members on two statements of trust and cooperation. These statements were: "I often socialize with landowners in my area" (t= 3.144, P= 0.002; χ^2= 8.761, P= 0.003) and "If leading landowners in my area urged others to follow deer hunting guidelines, most would voluntarily comply" (t= 2.260, P= 0.025; χ^2= 6.901, P= 0.009). Large landowners scored higher than small landowners for three statements: "I often socialize with landowners in my area" (t= -2.079, P= 0.039; χ^2= 4.295, P= 0.038), "I consider many people in the area I live to be friends" (t= -3.130, P= 0.002; χ^2= 0.429, P= 0.513), and "I would provide time to help non-kin landowners in my area" (t= -2.133, P= 0.034; χ^2= 5.274, P= 0.002). There were no regional differences between landowners.

Table 16. Landowner response to "How strongly do you agree or disagree with each of the following statements about trust and cooperation among people?" (3= strongly agree…-3= strongly disagree).

Statement	Mean Response Value	SE	95% CI
I trust people in area	1.61	0.07	0.14
I consider people in area friends	1.55	0.09	0.18
I know people in area	1.18	0.09	0.18
I socialize with people in area	0.91	0.10	0.20
Trust Index	**1.27**	**0.07**	**0.14**
I would loan equipment to people in area	0.79	0.10	0.20
I would lend money to people in area	-1.15	0.10	0.20
Reciprocity Index	**-0.17**	**0.09**	**0.18**
I would provide time to people in area	1.55	0.07	0.14
Most people can be trusted	1.36	0.08	0.16
Most would comply - hunting guidelines	0.61	0.10	0.20
Most would comply - land conservation	0.42	0.09	0.18

Despite the differences between survey groups on individual statements, no differences were found between members and non-members for the trust index (t= 1.773, P= 0.077; χ^2= 2.832, P= 0.092) or reciprocity index (t= 1.902, P= 0.058; χ^2= 1.854, P= 0.173). Large owners exhibited more trust (t= -2.624, P= 0.009; χ^2= 10.737, P= 0.001), but there was no significant difference for reciprocity (t= -1.591, P= 0.113; χ^2= 2.450, P= 0.117). There were no differences between regional groups for trust (t= -

0.425, P=0.671; χ^2= 0.113, P= 0.737) or reciprocity (t= 0.183, P= 0.855; χ^2= 0.158, P= 0.691) (Fig. 18).

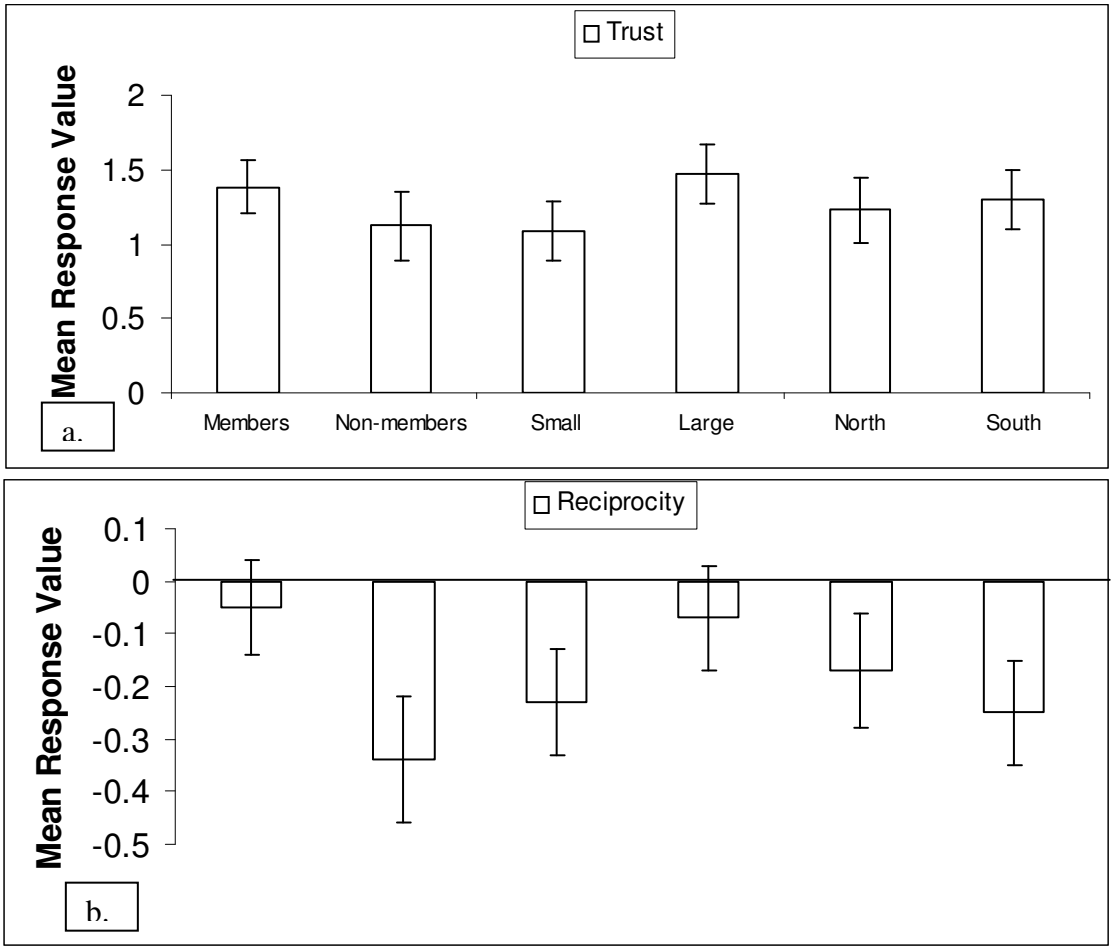

Figure 18. Levels of trust (a) and reciprocity (b) of survey groups (response range +3 to -3) (error bars show 95% CI).

Demographics and Social Capital

Demographic measurements were also analyzed with respect to social capital. Age was examined, and there were no significant correlation between age and

community involvement (F= 0.937, P= 0.603), trust (F= 1.180, P= 0.203), or reciprocity (F= 1.152, P= 0.237).

There was a significant difference in trust between groups based on place of residence (F= 19.17, P< 0.001; χ^2= 50.061, P< 0.001) (Fig. 19). Respondents who live in a village or town of under 10,000 inhabitants have higher levels of trust than those that live in an urban area (P< 0.001, P= 0.020, respectively). No such differences were found for community involvement (F= 0.596, P= 0.618; χ^2= 1.917, P= 0.590) or reciprocity (F= 0.955, P= 0.415; χ^2= 2.731, P= 0.435).

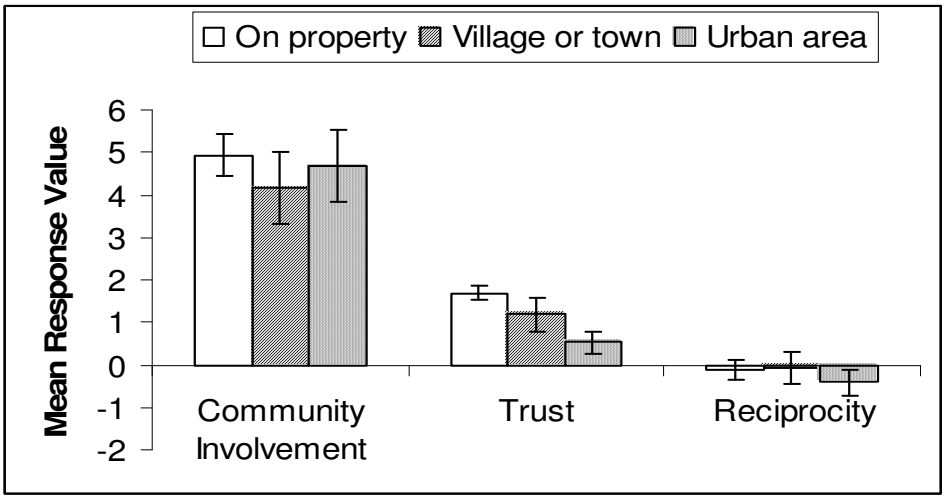

Figure 19. Respondent levels of social capital components, categorized by residence (error bars show 95% CI).

There were no significant differences in community involvement (F= 0.788, P= 0.559; χ^2= 3.772, P= 0.583) or trust (F= 1.102, P= 0.360; χ^2= 9.131, P= 0.104) for respondents with different education levels, but there was a negative trend for reciprocity

(F= 2.434, P= 0.035' χ^2= 12.356, P= 0.030); as respondents became more educated, their reciprocity decreased (Fig. 20).

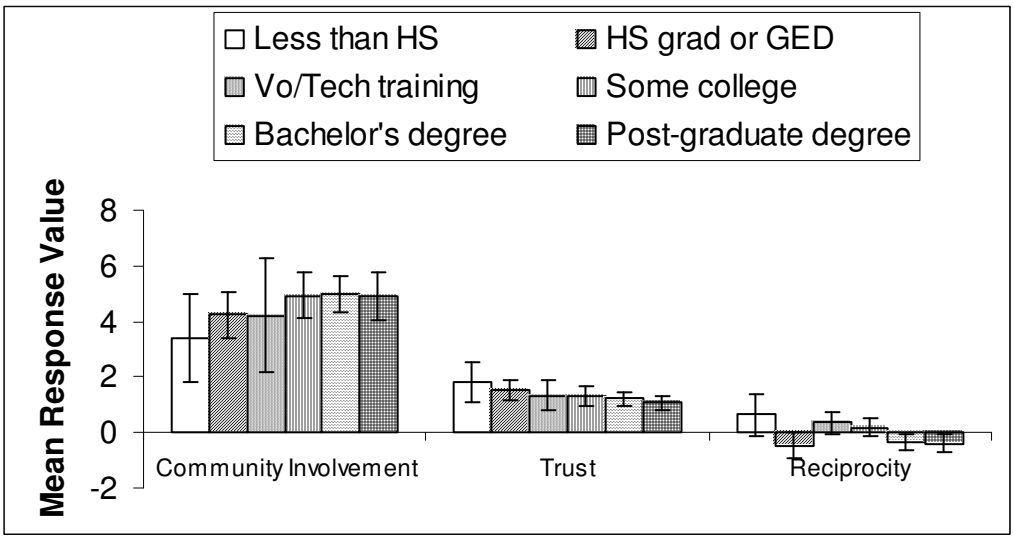

Figure 20. Respondent levels of social capital components, categorized by education (error bars show 95% CI).

There were significant differences in community involvement (F= 3.136, P= 0.005; χ^2= 18.179, P= 0.006), trust (F= 7.801, P< 0.001; χ^2= 39.979, P<0.001) and reciprocity (F= 2.356, P= 0.031; χ^2= 14.183, P= 0.028) between occupation groups. In all cases, those claiming agriculture as an occupation scored higher than other groups. For community involvement, agriculture was significantly higher than retired (P= 0.004). For trust, agriculture had significantly higher scores than professional (P= 0.000), homemaker (P= 0.032), and business owner (P= 0.013). For reciprocity, agriculture did not score significantly higher than other occupation groups (Fig. 21).

Significant differences between income groups were found for trust (F= 2.668, P= 0.033; χ^2= 12.393, P= 0.015), but not reciprocity (F= 1.076, P= 0.369; χ^2= 3.999, P= 0.406) or community involvement (F= 1.844, P= 0.121; χ^2= 6.630, P= 0.157). Within individual groups, respondents with incomes between $50,000 and $75,000 had a higher trust score than respondents with incomes over $100,000 (P= 0.032) (Fig. 22).

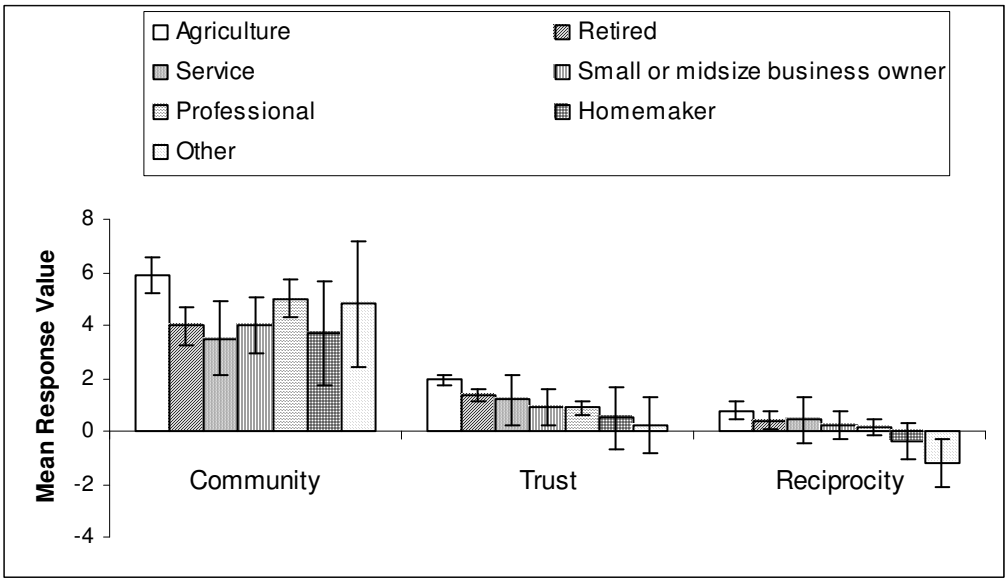

Figure 21. Respondent levels of social capital components, categorized by occupation (error bars show 95% CI).

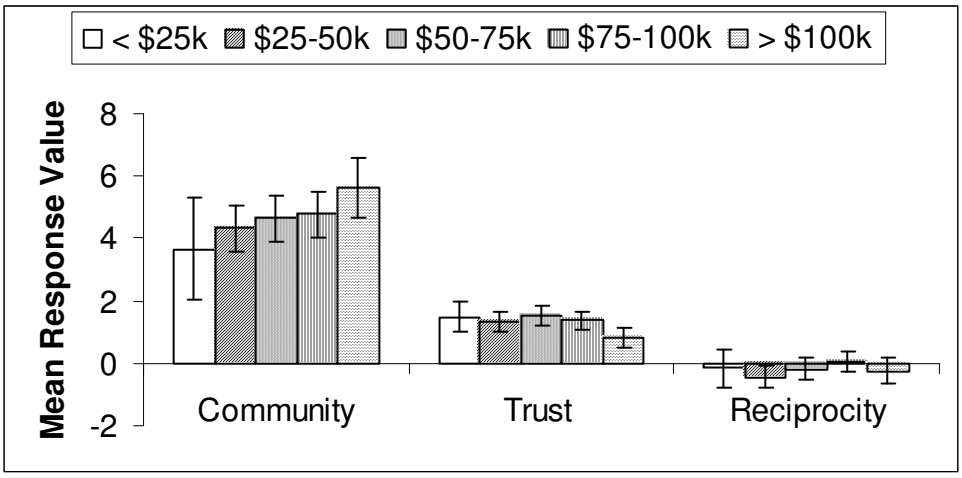

Figure 22. Respondent levels of social capital, categorized by income (error bars show 95% CI).

Wildlife Management Association Supplement

At the end of the survey, a supplemental section was included for Wildlife Management Association members to complete. These questions were analyzed with trust and reciprocity, to determine whether there were any differences between associations.

WMA member survey participants were asked how many members were in their association. The mean number of members was 56.11 (n= 107), with a range of 10-200 (Fig. 23). There were no significant differences in trust (F= 1.093, P= 0.368) or reciprocity (F= 1.482, P= 0.085) for respondents from different size associations.

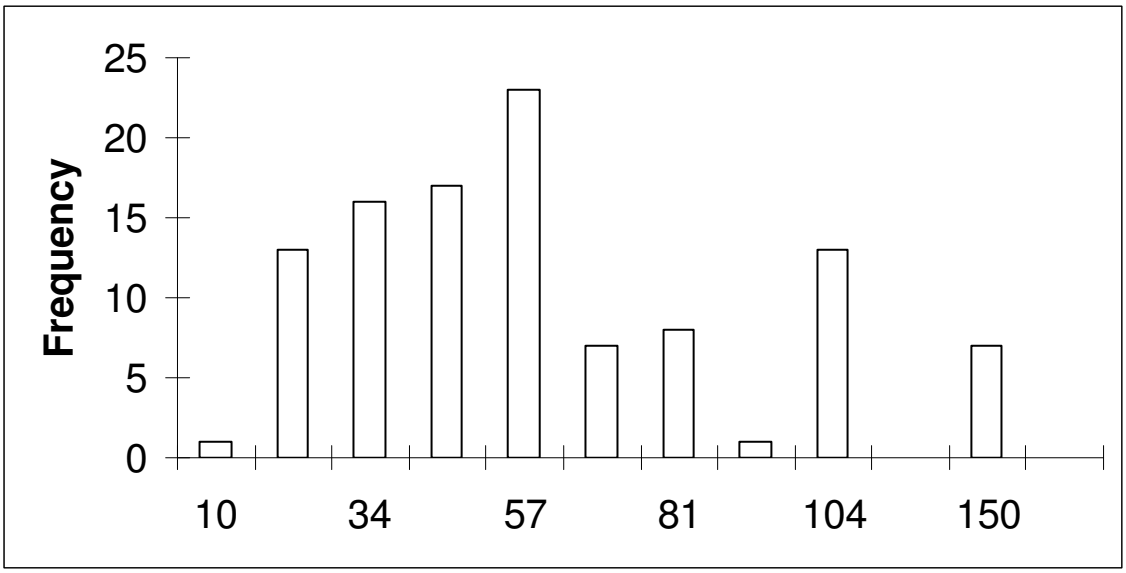

Figure 23. Histogram of response to the question "About how many members does your Association have?"

Members were next asked how many years they have been association members. The mean length of membership was 7.12, with a range of 0-30 (Fig. 24). Members who have been in associations longer scored higher on trust (F= 1.897, P= 0.017), but not reciprocity (F= 0.836, P= 0.666).

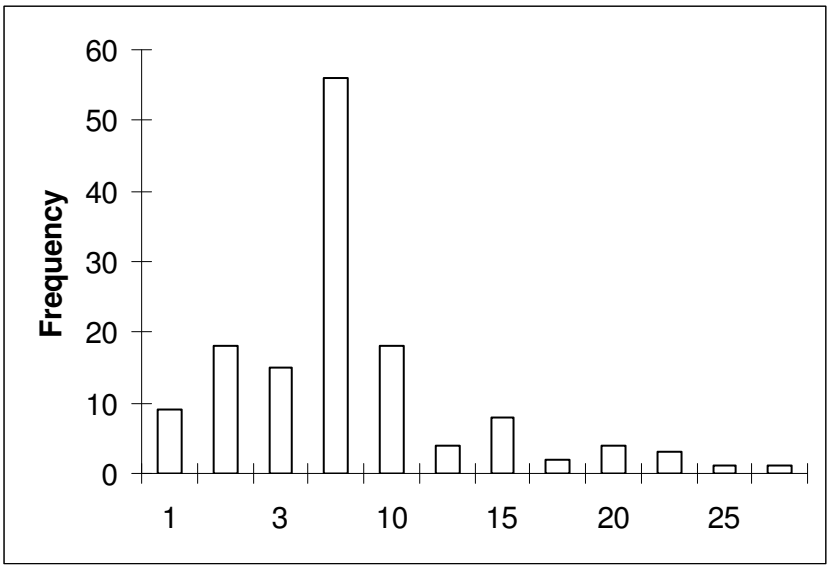

Figure 24. Histogram of response to the question "How many years have you been a member of this Association?"

Members were also asked how many times their association meets per year, and the average number of meetings was 3.35, with a range of 1-12 (Fig. 25). There were no significant differences between number of meetings and trust ($F= 0.990$, $P= 0.447$) or reciprocity ($F= 0.998$, $P= 0.441$).

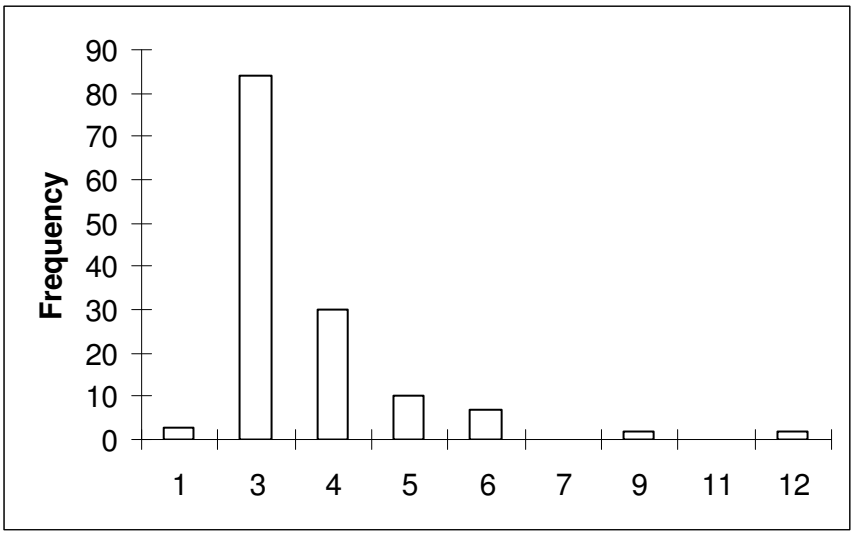

Figure 25. Histogram of response to the question "About how many times per year does your association meet?"

Next, members were asked how many association meetings they attend each year. This number was divided by the total number of meetings indicated by each respondent to calculate percentage of meetings attended. Mean attendance was 78% (SE= 0.03, 95% CI= 0.06) (Fig. 26). This attendance figure was analyzed with trust and reciprocity, and there was a significant difference for trust ($F= 3.747$, $P< 0.000$), but not reciprocity ($F= 0.740$, $P= 0.721$). Members with greater attendance exhibited greater trust than those who don't attend as many meetings (Table 17).

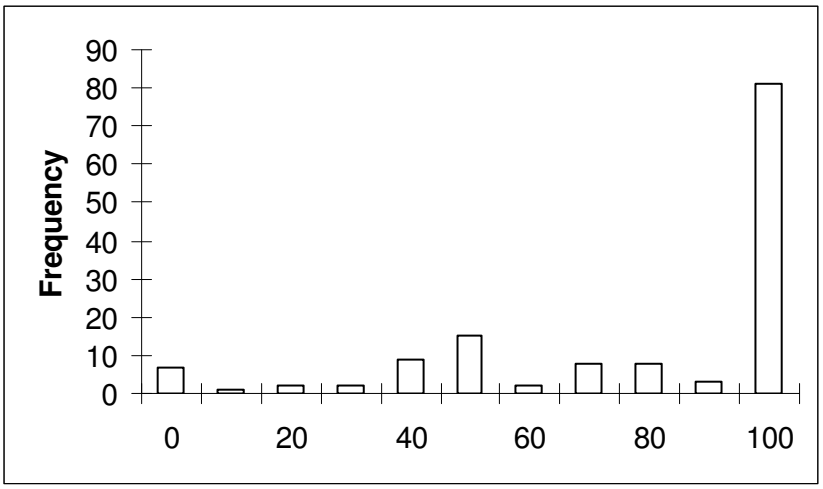

Figure 26. Histogram of percentage of Association meetings attended, as reported by members.

Table 17. ANOVA results of comparison between Association factors and social capital components (bold numbers denote significant comparisons).

				Trust		Reciprocity	
Factor	Mean Response Value	SE	95% CI	F	P	F	P
Number of Members	56.11	3.29	6.48	1.093	0.386	1.482	0.085
Years of Membership	7.12	0.49	0.97	1.897	**0.017**	0.836	0.666
Number of Meetings	3.35	0.14	0.28	0.990	0.447	0.998	0.441
Percent Attendance	78.27	2.60	0.51	3.747	**<0.001**	0.740	0.721

A list of means of communication with members was presented, and respondents were asked to rate the level of use of each of them. Five choices were presented, ranging from “commonly used” to “not used”, along with “not sure”, which was excluded from this analysis. Each remaining choice was given a score from 1-4, with 1 for “not used”

and 4 for "commonly used." A list of communication methods and their level of use, along with P-values, is presented in Table 18.

Each member's trust and reciprocity scores were compared to their response for each of the communication methods. This allows analysis of the effects of different types of communication, and the amount of their use, on social capital. Increased use of three methods was related to increased trust. They were: face to face (F= 4.064, P= 0.008; χ^2= 6.450, P=0.040), phone (F= 4.825, P= 0.003; χ^2= 13.541, P=0.004), and workshop/seminar (F= 2.904, P= 0.038; χ^2= 8.352, P= 0.039) (Table 18). No communication methods were correlated with trust. These results suggest that frequent personal interaction, whether in person or over the phone, leads to increased social capital between WMA members. WMAs would be encouraged to make use of these methods to increase cohesion and familiarity between members.

Table 18. WMA respondents' indication of level of use of different means of communication within their association, and results of ANOVA comparisons between each method and trust and reciprocity (4= commonly used…1= not used; bold numbers denote significant comparisons).

				Trust		Reciprocity	
Method	Mean Response Value	SE	95% CI	χ^2	P	χ^2	P
Face to Face	3.34	0.08	0.16	6.450	**0.040**	1.300	0.522
Newsletter	3.26	0.09	0.18	2.186	0.535	2.767	0.429
Phone	1.93	0.08	0.16	13.541	**0.004**	5.830	0.120
Workshop/ Seminar	1.91	0.08	0.16	8.352	**0.039**	6.784	0.079
Email	1.10	0.11	0.22	1.639	0.650	0.882	0.830
Web Site	0.42	0.08	0.16	2.087	0.555	2.298	0.513

WMA members were also asked to rate their association in several categories. The first three categories were organizational leadership, regular meetings, and communication. These ratings were compared to members' trust and reciprocity. There was a significant relationship between high ratings for each of these and high levels of trust (leadership F= 2.596, P=0.021; meetings P=3.497, P=0.005; communication F= 2.373, P= 0.033). There were significant relationships for reciprocity and regular meetings (F= 2.291, P= 0.049) and communication (F= 2.563, P= 0.022), but not leadership (F= 1.942, P= 0.078) (Table 19). Like the previous question, this suggests that regular meetings and good communication can lead to greater social capital within WMAs.

Table 19. ANOVA results of comparison between member-rated categories and social capital (bold numbers denote significant differences).

				Trust		Reciprocity	
Category	Mean Response Value	SE	95% CI	F	P	F	P
Leadership	5.60	0.11	0.22	2.596	**0.021**	1.942	0.078
Regular Meetings	5.48	0.11	0.22	3.497	**0.005**	2.291	**0.049**
Communication	5.06	0.13	0.26	2.373	**0.033**	2.563	**0.022**

CHAPTER VI

DISCUSSION

For many land management practices and opinions, land size seemed to be a more important factor than WMA membership. Targeting large landowners with new conservation initiatives is already more efficient because more land can be enrolled in a program for the same investment of time and effort in recruiting, but they also seem more willing to participate. As land fragmentation continues on the Edwards Plateau, the number of large landowners will decline while smaller landholdings will increase. Policymakers and conservationists will have to find ways to increase the interest of small landowners in land management programs. Cooperative associations may be one way to accomplish this.

The economic potential of fee hunting has increased landowner interest in wildlife management, as evidenced by the rise of Wildlife Management Associations. Therefore, it would seem logical that, if landowners realize the economic potential of groundwater marketing, interest in groundwater management may grow in a similar manner. However, wildlife also has a recreational component. Many landowners in the Edwards Plateau and elsewhere enjoy hunting with friends and family, and proper management of wildlife can improve these experiences. Groundwater doesn't evoke these same feelings; this survey shows that interest in cooperatively managing groundwater pales next to interest in wildlife. This may be a barrier to getting landowners involved in local, cooperative groundwater management.

Furthermore, wildlife and groundwater have some inherent differences. Wildlife is a public good with private access rights controlled by the state (through hunting licenses and regulations), while groundwater is a public good with private access rights unrestricted by government. Also, while wildlife is a luxury good, water is necessary for life.

Respondents also expressed some fears that likely affect their perceptions of groundwater management. There was mistrust of government, especially the federal government. Opinions of Texas Parks and Wildlife were positive, however, and respondents were slightly favorable towards the formation of groundwater conservation districts. This suggests that frequent, positive interactions, in the case of TPWD, and meaningful local control, in the case of GCDs, may allow government agencies to overcome inherent mistrust of government among Texas landowners. Respondent comments also suggested some fear of large corporations dominating water markets. Another interesting finding was that WMA members were significantly more likely to cite "don't trust other members of an Association to comply with water withdrawal agreements" as a reason not to join a groundwater marketing association. Thus it appears that trusting a neighbor to adhere to wildlife management regulations is easier than trusting them to adhere to groundwater regulations. In a related finding, respondents, including WMA members, had a more favorable opinion of GCDs than of private groundwater marketing cooperatives. In effect, they trusted a quasi-governmental organization more than a landowner association for groundwater management. This seems to contradict respondents' general views towards government,

but the word “marketing” may be what prompted a negative reaction to the latter entity, rather than “cooperative.”

For these reasons, the possibility of using WMAs as a basis for managing groundwater seems unfeasible. Interest in wildlife among WMA members didn’t translate to interest in groundwater management. Therefore, to manage groundwater locally, it may be necessary to form alternative associations. Although there would probably be some overlap in membership with WMAs, members of these associations would probably have different perceptions and opinions than WMA members. To facilitate creation of these groups, it would be worthwhile to examine factors affecting the formation of WMAs in Texas. For example, was it landowners or government officials who provided the impetus? Also, what factors motivated people to join? Recreational interesting in hunting and income from fee-based hunting are likely to be major factors, but which is more important? The answers to these questions may help target specific landowners for recruitment.

For groundwater marketing to be accepted, landowners would need to become more familiar with it, possibly by seeing it successfully enacted elsewhere. If landowners see that they can benefit financially while maintaining local control of their right to access groundwater, cooperative management for this common-pool resource might become more widespread, as it has with wildlife. While the respondents to this survey were strongly opposed to groundwater marketing, other Texas landowners have embraced the idea (via the Edwards Aquifer Authority and Brazos Valley Water Alliance (Wagner 2005), for example). It would be worthwhile to survey these

landowners, to examine factors that influence people to participate in groundwater marketing. Information gleaned in such a survey would be useful in educating landowners in the Edwards Plateau and elsewhere on the benefits of groundwater marketing.

This study found intra-association social capital differences based on communication, leadership, and meeting frequency. It makes intuitive sense that more personal contact between members will lead to greater social capital. Increased meeting frequency is one way to encourage this, along with workshops and seminars. Wagner (2005) also found that frequency of meetings is correlated to increased social capital. It also makes sense that strong leadership will increase confidence in the longevity and success of a WMA, and greater willingness to stay involved. Wagner also found a negative correlation between number of members in an Association and social capital; however, no such difference was found on the Edwards Plateau. Further exploration of these variables would be useful to WMAs and other landowner cooperatives as they attempt to build social capital between members.

This study was limited by difficulty in identifying WMAs and acquiring membership lists and county appraisal data. No single organization maintains information about all WMAs in Texas; many are not registered with the Texas Organization of Wildlife Management Associations (TOWMA). Most were identified by contacting county extension agents or TPWD biologists. In addition, some associations were willing to participate in the study, while others were not. County appraisal offices also offered varying levels of cooperation in providing landowner

information. These problems affected the size of the pool from which the survey population was selected. By employing county extension agents, TPWD biologists, and University professors in the recruitment process, more WMAs might be inclined to participate in future surveys.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Six hypotheses were proposed for this study of landowners' perceptions of coordinated wildlife and groundwater management. The results and conclusions regarding each of these are as follows:

H1: The first hypothesis was that landowner association membership leads to increased investment in habitat improvement and land management. WMA members did engage in more wildlife management practices than non-members, scoring higher on the deer index ($P< 0.001$) and engaging in more coyote control ($P< 0.001$) and provision of supplemental shelter ($P= 0.001$). However, members did not show significantly greater use of land management activities or participation in government conservation programs. WMA members can be expected to be more active in wildlife management, since that is the point of association membership, but this does not carry over to other management practices unrelated to wildlife, such as groundwater management.

H2: The second hypothesis was that members of landowner associations show a greater willingness than non-members to enroll in cooperative management initiatives. They were more favorable to the idea of joint decision making about wildlife management ($P= 0.005$) and Wildlife Management Associations as a vehicle for coordinated wildlife management ($P< 0.001$). One can conclude that this more favorable disposition stems from members experience with successful cooperative management.

By educating other landowners about such ventures, such associations could gain more widespread appeal.

H3: The third hypothesis was that members of landowner associations are more willing to enter into coordinated groundwater marketing arrangements. This was not the case. Their opinion of private groundwater cooperatives for water marketing was not more favorable than that of non-members, and they did not indicate that they were more likely to join a groundwater marketing association. Therefore, members' willingness to enroll in cooperative management initiatives relating to wildlife did not carry over to groundwater management. Survey respondents as a whole seemed wary of the idea of groundwater marketing. Some fear was expressed that large corporations would dominate free market groundwater exchanges. Landowners also appear to be worried about government interference with groundwater.

H4: The fourth hypothesis was that large-property owners are more interested in wildlife management and groundwater marketing than small-property owners, and exhibit more social capital. Large owners performed more deer-related actions ($P < 0.001$), coyote control ($P < 0.001$), and hog control ($P = 0.001$) than small-property owners. Large owners were not more interested in groundwater marketing cooperatives or groundwater marketing associations than their small-property counterparts. There were more social capital differences between these two groups than any others, as large landowners scored higher on community involvement ($P < 0.001$) and trust ($P = 0.002$), but not reciprocity.

H5: The fifth hypothesis was that landowners in the northern Edwards Plateau exhibit more interest in wildlife management and groundwater marketing, and exhibit more social capital. There were few differences between northern and southern survey groups. One was that southern landowners performed more coyote control (P= 0.029) and hog control (P= 0.005) than northerners. Also, while both groups were unfavorable towards the purchase and sale of groundwater, northerners were to a greater degree (P= 0.048). There were no social capital differences between region groups. The differences in property size between northern and southern groups found on appraisal list data did not lead to significant differences between the two groups in the issues explored in this project.

H6: The final hypothesis was that landowner associations increase social capital. WMA members showed differences from non-members in only one component of social capital: community involvement. Members were more involved in community organizations than non-members (P= 0.005). Members and non-members did not differ significantly in the areas of trust or reciprocity, although members did have higher mean values for these components. This may be because Edwards Plateau landowners already have inherently high levels of social capital. The non-member mean for trust was 1.11 on a +3 to -3 scale, which is a substantial positive value. Association size may also be a factor. Pretty and Ward (2001) found that smaller resource management groups (<30 members) exhibited higher social capital. Wagner found similar results in the Central Post Oak Savannah in his study. Only four of the 11 WMAs surveyed here had less than 30 members, and one Association had 115 members. It could be that Edwards Plateau

WMAs are too large to build trust and reciprocity between members. There were differences within associations based on regular meetings, communication, and leadership, however, so it appears that these associations can improve ties between members by increasing opportunities for contact.

Respondents to this survey, regardless of WMA membership, did not have favorable opinions about groundwater marketing. Mistrust of government and other landowners, as well as lack of familiarity, seem to be major reasons for this. Because of inherent differences between wildlife and groundwater, WMAs are unlikely to be effective vehicles for coordinated local groundwater management. However, WMAs do play a valuable role in wildlife management. By facilitating interpersonal contact between members, WMAs can increase social capital, which may make the Associations and their management initiatives more successful.

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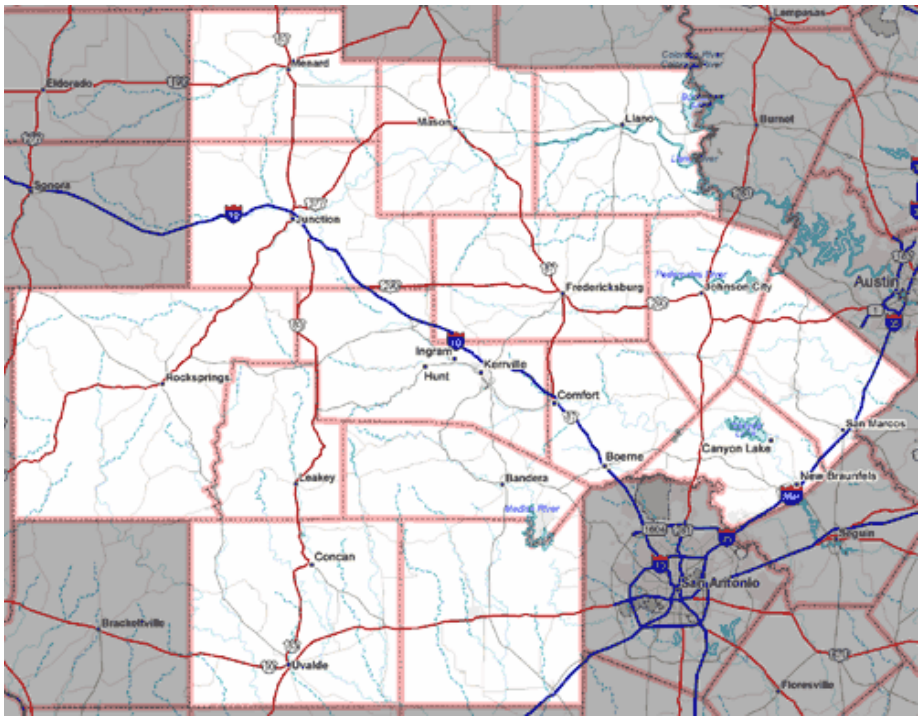
APPENDIX A

MAIL SURVEY QUESTIONNAIRE

Coordinated Wildlife and Groundwater Management in the Edwards Plateau:

A Mail Survey of Landowners



Department of Rangeland Ecology and Management
Texas A&M University
2126 TAMU
College Station, TX 77843-2126

June 2005

INTRODUCTION

We are asking that this questionnaire be completed by the addressee or by the individual most knowledgeable about your rural property.

We want to assure you that your participation and responses to all questions will be kept strictly confidential. Please do not remove the tracking number on the cover of the questionnaire, which allows us to remove your name from our mailing list once we receive your completed questionnaire. This way we can avoid sending you reminders.

If you encounter a question that does NOT APPLY to your property, please indicate this by writing "NA" in the margin next to the question. If you encounter a question for which you DON'T KNOW the answer, please indicate this by writing "DK" in the margin next to the question.

If you have any questions, please contact Craig Limesand, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126 (telephone: 979-574-6401 or email: ***climesand@tamu.edu***).

INITIAL QUESTION: First, we want to make sure you should complete the questionnaire.

Are you the owner, operator, or manager of at least 40 acres of private land?

☐ No ? Please stop here and return the survey in the envelope provided. It is important we hear back from everyone who receives a questionnaire. We thank you for taking the time to place the entire questionnaire in the enclosed addressed envelope, and returning it to us. No postage is necessary.

☐ Yes ? Please go to SECTION A on the next page and complete the questionnaire.

In answering the questionnaire, please provide answers for the land for which you pay property taxes in a county in the Edwards Plateau. Please **DO NOT** include responses for land you own outside of this region. **IF YOU OWN SEVERAL TRACTS OF LAND IN ONE OR MORE COUNTIES IN THE EDWARDS PLTEAU, PLEASE ANSWER THE QUESTIONS BASED ON YOUR TOTAL LANDHOLDING IN THIS REGION.**

SECTION A – CHARACTERISTICS OF YOUR PROPERTY AND LAND MANAGEMENT

A1. ***In which of the following COUNTIES is your land predominantly located?***
(Please check ONE box only)

☐ Bandera	☐ Burnett	☐ Coryell
☐ Edwards	☐ Gillespie	☐ Kerr
☐ Lampasas	☐ Llano	☐ Mason
☐ Menard	☐ San Saba	☐ Other _____

A2. **How many ACRES of land do you own in the Edwards Plateau?** _____ acres

A3. **How long have you or your family owned this acreage?**

(If multiple tracts are owned, please provide the longest period of time) _____ years

A4. ***Approximately what percentage of your property is comprised of each of the following LANDCOVER TYPES?***
(Please ensure that your answers TOTAL 100%)

- Non-flooded native rangeland _____%
- Non-flooded woodland _____%
- Bottom land woodland (flood-prone) _____%
- Bottomland pasture (flood prone) _____%
- Open water wetlands (sloughs, lakes, marsh, etc. _____%
- Improved pasture (e.g., bermudagrass, bahiagrass, K-R bluestem, etc) _____%
- Cropland _____%
- Other land cover (Please specify) _____ _____%

Total 100 %

A5. ***Approximately what percent of your PROPERTY INCOME is derived from each of the following activities?***
(Please ensure that your answers TOTAL 100%)

- Income from the sale of domestic livestock _____%
- Fees for hunting of native or exotic wildlife _____%
- Income from the sale of wildlife for breeding stock, meat or other products _____%
- Income from the sale of crops _____%
- Income from recreation related activities (other than hunting) _____%
- Government program payments _____%
- Mineral sales and leases _____%
- Other (Please specify) _____ _____%

Total 100 %

A6. ***How important is each of the following LAND USE PRIORITIES to you?***
(In each row, circle the ONE value that best reflects your opinion).

+3 = very important … 0 = neutral … -3 = not at all important							
Farming/hay production	+3	+2	+1	0	-1	-2	-3
Livestock production	+3	+2	+1	0	-1	-2	-3
Wildlife management	+3	+2	+1	0	-1	-2	-3
Lease hunting	+3	+2	+1	0	-1	-2	-3
Non-lease hunting	+3	+2	+1	0	-1	-2	-3
Nature tourism/recreation	+3	+2	+1	0	-1	-2	-3
Place to live	+3	+2	+1	0	-1	-2	-3
Relaxation/leisure	+3	+2	+1	0	-1	-2	-3
Scenic beauty	+3	+2	+1	0	-1	-2	-3
Investment	+3	+2	+1	0	-1	-2	-3
Commercial/residential development	+3	+2	+1	0	-1	-2	-3
Mineral extraction	+3	+2	+1	0	-1	-2	-3
Other (Please describe) _____	+3	+2	+1	0	-1	-2	-3

A7. ***Please indicate the approximate number of acres of your property affected by each of the following LAND MANAGEMENT ACTIVITIES during the last three years.***

- Mechanical or chemical brush control _____ acres
- Controlled burning _____ acres
- Native plant restoration _____ acres
- Erosion control _____ acres
- Rotational grazing _____ acres
- Overseeding improved pasture with winter cover crops _____ acres
- Disking to produce wildlife foods _____ acres
- Wildlife food plots _____ acres
- Other (Please describe)_____ _____ acres

A8. ***Have you previously, or are you currently participating in any of the following federal or state funded LAND IMPROVEMENT PROGRAMS?***
(In each row, check only ONE box)

	Am currently	Have in the past	Never
Environmental Quality Incentives Program (EQIP)	☐	☐	☐
Conservation Reserve Program (CRP)	☐	☐	☐
Wildlife Habitat Incentives Program (WHIP)	☐	☐	☐
Wetland Reserve Program (WRP)	☐	☐	☐
Partners for Wildlife	☐	☐	☐
Landowner Incentive Program (LIP)	☐	☐	☐
Pastures for Upland Birds Program (PUB)	☐	☐	☐
Other (Please describe) _____	☐	☐	☐

A9. ***Please indicate how many times each of the following WILDLIFE MANAGEMENT and WATER CONSERVATION ACTIONS have occurred on your property in the last three years.*** (In each row, circle ONE value only).

WILDLIFE MANAGEMENT					
Deer counts	0	1	2	3	3+
Update deer harvest records	0	1	2	3	3+
Selective buck harvest	0	1	2	3	3+
Selective doe harvest	0	1	2	3	3+
Coyote control	0	1	2	3	3+
Feral hog control	0	1	2	3	3+
Fire ant control	0	1	2	3	3+
Provide supplemental shelter (brush piles, nest boxes, etc.)	0	1	2	3	3+
WATER CONSERVATION					
Terracing	0	1	2	3	3+
Construction of ponds and shallow water impoundments	0	1	2	3	3+
Shape waterways	0	1	2	3	3+
Improve streamside buffer areas (vegetated waterways)	0	1	2	3	3+
Exclude livestock from streamsides	0	1	2	3	3+
Reseed with native plants	0	1	2	3	3+
Woody plant control for increased water infiltration	0	1	2	3	3+
Rainwater harvesting	0	1	2	3	3+

A10. ***How important is each of the following issues to you when making decisions about RANGELAND IMPROVEMENT PRACTICES?*** (In each row, circle the ONE value that best reflects your opinion).

+3 = very important … 0 = neutral … -3 = not at all important							
VEGETATION							
Improve perennial forage supply	+3	+2	+1	0	-1	-2	-3
Improve forage quantity	+3	+2	+1	0	-1	-2	-3
Improve forbs and browse production	+3	+2	+1	0	-1	-2	-3
Improve wildlife habitat	+3	+2	+1	0	-1	-2	-3
Control the invasion and spread of woody plants (brush)	+3	+2	+1	0	-1	-2	-3
Re-vegetation for erosion control	+3	+2	+1	0	-1	-2	-3
WATER							
Maintain buffers along streamside areas	+3	+2	+1	0	-1	-2	-3
Protect or improve riparian areas (drainage areas, wetlands)	+3	+2	+1	0	-1	-2	-3
Increase surface water infiltration	+3	+2	+1	0	-1	-2	-3
Improve water supply on your land	+3	+2	+1	0	-1	-2	-3
Increase stream flow	+3	+2	+1	0	-1	-2	-3
Increase groundwater recharge	+3	+2	+1	0	-1	-2	-3
ECONOMIC							
Improve real estate value	+3	+2	+1	0	-1	-2	-3
Improve aesthetic value	+3	+2	+1	0	-1	-2	-3
EFFICACY							
Demonstrated effectiveness of improvement practice	+3	+2	+1	0	-1	-2	-3
Cost of improvement practice	+3	+2	+1	0	-1	-2	-3

SECTION B – WILDLIFE AND GROUNDWATER MANAGEMENT OPINIONS

B1. ***What is your opinion regarding each of the following WILDLIFE MANAGEMENT ISSUES?***
(In each row, please circle the ONE value that best reflects your opinion).

+3 = very favorable … 0 = neutral … -3 = very unfavorable, U = uncertain								
Public owns native wildlife on private land	+3	+2	+1	0	-1	-2	-3	U
Free movement of native wildlife across the landscape	+3	+2	+1	0	-1	-2	-3	U
High fencing to restrict the movement of wildlife	+3	+2	+1	0	-1	-2	-3	U
Control of woody plants to improve wildlife habitat	+3	+2	+1	0	-1	-2	-3	U
Use of fire to improve wildlife habitat	+3	+2	+1	0	-1	-2	-3	U
Improvement of endangered species habitat	+3	+2	+1	0	-1	-2	-3	U
Assistance with developing wildlife management plans	+3	+2	+1	0	-1	-2	-3	U
Cost-sharing programs for wildlife habitat improvements	+3	+2	+1	0	-1	-2	-3	U
Conservation easements	+3	+2	+1	0	-1	-2	-3	U
The US Fish and Wildlife Department	+3	+2	+1	0	-1	-2	-3	U
The Natural Resource Conservation Service	+3	+2	+1	0	-1	-2	-3	U
Texas Parks and Wildlife Department	+3	+2	+1	0	-1	-2	-3	U
Non-government organizations (e.g., Nature Conservancy)	+3	+2	+1	0	-1	-2	-3	U
Autonomous decision-making authority by landowners about native wildlife management on their land	+3	+2	+1	0	-1	-2	-3	U
Joint decision making by neighboring landowners about native wildlife management on their land	+3	+2	+1	0	-1	-2	-3	U
Wildlife Management Associations as a vehicle for coordinated wildlife management	+3	+2	+1	0	-1	-2	-3	U

B2. ***What is your opinion regarding each of the following GROUNDWATER ISSUES?***
(In each row, please circle the ONE value that best reflects your opinion).

+3 = very favorable … 0 = neutral … -3 = very unfavorable, U = uncertain								
The “rule of capture” for groundwater in Texas	+3	+2	+1	0	-1	-2	-3	U
A permit system for non-domestic use of groundwater	+3	+2	+1	0	-1	-2	-3	U
Groundwater pumping based on sustainable aquifer yield	+3	+2	+1	0	-1	-2	-3	U
Local government oversight of groundwater issues	+3	+2	+1	0	-1	-2	-3	U
State government oversight of groundwater issues	+3	+2	+1	0	-1	-2	-3	U
Federal government oversight of groundwater issues	+3	+2	+1	0	-1	-2	-3	U
The purchase and sale of groundwater in general	+3	+2	+1	0	-1	-2	-3	U
Your right to buy and sell groundwater	+3	+2	+1	0	-1	-2	-3	U
Your neighbor’s right to buy and sell groundwater	+3	+2	+1	0	-1	-2	-3	U
Private "groundwater cooperatives" for water marketing	+3	+2	+1	0	-1	-2	-3	U
Formation of groundwater conservation districts (GCDs)	+3	+2	+1	0	-1	-2	-3	U
The transfer of groundwater from rural to urban uses	+3	+2	+1	0	-1	-2	-3	U
Evaluating ecological impacts of groundwater transfers	+3	+2	+1	0	-1	-2	-3	U
Evaluating socio-economic impacts of groundwater transfers	+3	+2	+1	0	-1	-2	-3	U

Section C – LANDOWNER MANAGEMENT ASSOCIATIONS

C1. ***Are you a MEMBER of a WILDLIFE MANAGEMENT ASSOCIATION?*** (Please check ONE box)

☐ Yes ☐ No

If Yes, please skip to Question C3 and **ANSWER SECTION F** at the end of the questionnaire.

If No, please go to Question C2 and **DO NOT ANSWER SECTION F** at the end.

C2. ***How important is each of the following reasons for NOT JOINING A WILDLIFE MANAGEMENT ASSOCIATION?***
(In each row, circle the ONE value that best reflects your opinion).

+3 = very important … 0 = neutral … -3 = not at all important							
I am not interested in managing my land for wildlife	+3	+2	+1	0	-1	-2	-3
Don't want to give up control of my land	+3	+2	+1	0	-1	-2	-3
Don't see any economic benefit to being a member	+3	+2	+1	0	-1	-2	-3
Don't believe in cooperative land management arrangements	+3	+2	+1	0	-1	-2	-3
Don't have time to be a member	+3	+2	+1	0	-1	-2	-3
Don't trust my neighbors	+3	+2	+1	0	-1	-2	-3
My property is by itself large enough for managing wildlife	+3	+2	+1	0	-1	-2	-3
Want a high fence around my own property	+3	+2	+1	0	-1	-2	-3
The Association in my area is poorly organized	+3	+2	+1	0	-1	-2	-3

C3. ***Is GROUNDWATER MARKETING currently occurring in your area?*** (Please check ONE box)

☐ Yes ☐ No ☐ Don't know

C4. ***If a GROUNDWATER MARKETING ASSOCIATION were to exist in your area how likely would you become a MEMBER?*** (Please check ONE box)

☐ Very likely ☐ Possibly ☐ Uncertain ☐ Unlikely ☐ Very unlikely

C5. ***How strongly do you agree with each of the following possible reasons for NOT JOINING A GROUNDWATER MARKETING ASSOCIATION?***
(In each row, circle the ONE value that best reflects your opinion).

+3 = strongly agree … 0 = neutral … -3 = strongly disagree, U = Uncertain							
Am not interested in selling groundwater	+3	+2	+1	0	-1	-2	-3
Don't think it is ethical to sell groundwater for profit	+3	+2	+1	0	-1	-2	-3
Don't think that joint groundwater marketing can work	+3	+2	+1	0	-1	-2	-3
Don't have time or interest to be an Association member	+3	+2	+1	0	-1	-2	-3
Don't believe in cooperative resource management	+3	+2	+1	0	-1	-2	-3
Don't think there would be sufficient economic benefit for being an Association member	+3	+2	+1	0	-1	-2	-3
Don't want to limit the amount of groundwater I can extract in order to meet Association restrictions	+3	+2	+1	0	-1	-2	-3
Don't trust other members of an Association to comply with water withdrawal agreements	+3	+2	+1	0	-1	-2	-3

Section D – CIVIC PARTICIPATION

D1. ***How involved are you and/or your spouse (if applicable) in each of the following types of COMMUNITY ORGANIZATIONS?***
(Please check only ONE box per row)

	Very	Somewhat	Not
Church groups	☐	☐	☐
Civic organizations (Rotary, Jaycees, Lions, etc.)	☐	☐	☐
Athletic/recreation groups (softball, soccer, card games, etc.)	☐	☐	☐
Education/school groups (PTA, Boosters, etc.)	☐	☐	☐
Youth-oriented groups (4-H, scouts, etc.)	☐	☐	☐
Community government (City, County commissions, etc.)	☐	☐	☐
Ranch/farm organizations (Farm Bureau, Cattleman's Assn, etc.)	☐	☐	☐
Other (Please describe) _____	☐	☐	☐

D2. ***Excluding weekly church services, approximately HOW MANY MEETINGS of the organizations listed in D1 above do you attend each year?*** _____

D3. ***In which of the following NATURAL RESOURCE ORGANIZATIONS are you a member?***
(Please check ALL THAT APPLY)

☐ Audubon Society
☐ Coastal Conservation Association
☐ Ducks Unlimited
☐ National Wild Turkey Federation
☐ Texas Farm Bureau
☐ The Nature Conservancy
☐ The Wildlife Society
☐ Land Trust Alliance
☐ Society for Range Management
☐ Soil and Water Conservation District
☐ Texas Deer Association
☐ Texas Wildlife Association
☐ National Wildlife Federation
☐ Quail Unlimited
☐ Sierra Club
☐ Conservation Easement
☐ Other (Please describe) _____

D4. ***How strongly do you agree or disagree with each of the following statements about TRUST AND COOPERATION among people?***
(In each row, circle the ONE value that best reflects your opinion).

+3 = strongly agree … 0 = neutral … -3 = strongly disagree							
Generally speaking, most people can be trusted	+3	+2	+1	0	-1	-2	-3
I know most of the people in the area that I live	+3	+2	+1	0	-1	-2	-3
I often socialize with landowners in my area	+3	+2	+1	0	-1	-2	-3
I consider many people in the area that I live to be friends	+3	+2	+1	0	-1	-2	-3
I trust the people in the area that I live	+3	+2	+1	0	-1	-2	-3
I would provide time to help non-kin landowners in my area	+3	+2	+1	0	-1	-2	-3
I would loan equipment to non-kin landowners in my area	+3	+2	+1	0	-1	-2	-3
I would lend money to non-kin landowners in my area	+3	+2	+1	0	-1	-2	-3
If leading landowners in my area urged others to follow land conservation practices, most would voluntarily comply	+3	+2	+1	0	-1	-2	-3
If leading landowners in my area urged others to follow deer hunting guidelines, most would voluntarily comply	+3	+2	+1	0	-1	-2	-3

SECTION E – PERSONAL INFORMATION

To understand differences among landowners regarding their interest and concerns about prescribed fire and cost-share programs, we ask you to provide some information about yourself. We want to assure you that **YOUR RESPONSES WILL BE KEPT STRICTLY CONFIDENTIAL**, and will not be shared with any individual, business, or government agency. Results of this study will be reported only in the form of statistical summaries of many operations. At no time will the identity of your operation be disclosed. We thank you in advance for your willingness to provide this information.

E1. ***In which year were you born?*** _____

E2. ***What is your gender?*** ☐ Male ☐ Female

E3. ***Where is your primary residence?***

☐ On my property
☐ Urban area
☐ Village or town under 10,000 inhabitants
☐ Other (Please describe) _____

E4. ***Is your rural property your primary residence?***

☐ Yes ☐ No

If Yes, how long have you lived there? _____ years

If No, about how far is your residence from your property by road? __ _____ miles

E6. ***What is your highest level of formal education?*** (Please check ONE Box only).

☐ Less than high school
☐ High School Graduate or GED
☐ Vocational/Technical training
☐ Some college
☐ Bachelor's degree
☐ Post-graduate degree

E7. ***Which of the following categories best describes your primary occupation?***
(Please check ONE Box only).

☐ Agriculture (Farming or ranching)
☐ Professional
☐ Service
☐ Other (Please describe) _____
☐ Homemaker
☐ Retired
☐ Small or midsized business owner

E8. ***Please check the category that best represents your household's total income before taxes in 2004.*** (Include net property income, income from wages, salaries, non-farm businesses, rental property, investments, retirement accounts, and other income sources).
(Please check ONE Box only).

☐ Less than $25,000
☐ $50,001 - $75,000
☐ Greater than $00,000
☐ $25,001 - $50,000
☐ $75,001 - $100,000

E9. **Approximately what percentage of your household's total income usually comes from activities related to your property?** _____%

SECTION F – WILDFILE MANAGEMENT ASSOCIATION MEMBER SUPPLEMENT

In this final section, we are asking for some additional information from landowners who are **MEMBERS OF A WILDLIFE MANAGEMENT ASSOCIATION**. Please provide answers for the same land for which you provided responses in the previous part of the survey questionnaire.

F1. ***In which county is your Association located?*** _____

F2. ***What is the name your Wildlife Association?*** _____

F3. ***About how many members does your Association have?*** _____

F4. ***How many years have you been a member of this Association*****?** _____

F5***. How many members of the Association are you related to?*** _____

F6. ***About how many times per year does your Association meet*****?** _____

F7. ***About how many meetings of your Association do you attend per year?*** _____

F8 ***Please indicate the level of use of various means of communication by your Wildlife Management Association.*** (Please check only ONE box per row)

	Commonly used	Somewhat used	Seldom used	Not used	No sur
Face to face interaction	☐	☐	☐	☐	☐
Email	☐	☐	☐	☐	☐
Phone	☐	☐	☐	☐	☐
Newsletter	☐	☐	☐	☐	☐
Web Site	☐	☐	☐	☐	☐
Workshops/Seminars	☐	☐	☐	☐	☐
Other (Please describe) _____	☐	☐	☐	☐	☐

F9 ***Please indicate how you rate your Wildlife Management Association in each of the following categories.***
(In each row, circle the ONE value that best reflects your opinion).

7= excellent… 4 = average… 1 = Poor							
Organizational leadership	7	6	5	4	3	2	1
Regular meetings	7	6	5	4	3	2	1
Communication (newsletter, website, etc)	7	6	5	4	3	2	1
Improved quantity of white-tailed deer	7	6	5	4	3	2	1
Improved quality of white-tailed deer	7	6	5	4	3	2	1
Improved habitat for other game species	7	6	5	4	3	2	1
Improved habitat for non-game species	7	6	5	4	3	2	1
Improved condition for rainfall infiltration	7	6	5	4	3	2	1
Improved condition for erosion control	7	6	5	4	3	2	1
Ability to cooperatively manage the use of groundwater	7	6	5	4	3	2	1

F10. ***Please check your level of agreement with each of the following statements about your Wildlife Management Association***:
(Please check only one box per row).

+3 = strongly agree … 0 = neutral … -3 = strongly disagree							
I know most of the members of my Association	+3	+2	+1	0	-1	-2	-3
I often socialize with members of my Association	+3	+2	+1	0	-1	-2	-3
I consider many members of my Association to be friends	+3	+2	+1	0	-1	-2	-3
I trust members of my landowner association	+3	+2	+1	0	-1	-2	-3
I would spend time to help non-kin Association members	+3	+2	+1	0	-1	-2	-3
I would loan equipment to non-kin Association members	+3	+2	+1	0	-1	-2	-3
I would lend money to non-kin members of my Association	+3	+2	+1	0	-1	-2	-3
If my Association urged its members to follow land conservation practices, most would voluntarily comply	+3	+2	+1	0	-1	-2	-3
If my Association urged members to follow deer hunting guidelines, most would voluntarily comply	+3	+2	+1	0	-1	-2	-3

Please write any other comments or suggestions that can help us better understand your perception about wildlife and groundwater management as it affects your ranching or farming operation.

_____

_____

_____

_____

_____

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_____

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_____

_____

_____

THANK YOU FOR TAKING THE TIME TO FILL OUT THIS QUESTIONNAIRE.

Your participation is greatly appreciated!!!

Please send the completed questionnaire to us in the enclosed postage-paid envelope.

APPENDIX B

DATA TABLES - SURVEY SECTION A

Table B1. Mean number of hectares owned by respondents.

Survey Group	Mean	SE	95% CI
All Respondents	290.1	29.46	58.04
WMA Members	337.7	43.81	86.51
Non-members	221.0	33.23	65.86
Small Owners	40.1	1.60	3.15
Large Owners	402.7	40.17	79.13
North	259.9	40.20	79.56
South	303.3	45.29	89.61

Table B2. Number of years respondents have owned their land (Fig. 2).

Survey Group	Mean	SE	95% CI
All Respondents	50.57	2.61	5.14
WMA members	53.96	3.56	7.04
Non-members	45.14	3.76	7.44
Small owners	34.24	4.05	8.04
Large owners	58.77	3.25	6.40
North	43.97	3.62	7.17
South	57.55	4.03	7.97

Table B3. Percent of property income from fee hunting (Fig. 5).

Survey Group	Mean	SE	95% CI
All Respondents	19.29	1.65	3.24
WMA Members	21.46	2.03	3.99
Non-members	16.22	2.78	5.49
Small Owners	13.93	3.19	4.90
Large Owners	22.12	1.96	4.45
North	14.86	2.19	4.34
South	23.77	2.63	5.20

Table B4. Importance of wildlife management and lease hunting land use priorities of respondents (+3 = very important…-3 = not at all important; *denotes significant differences) (Fig. 8).

Priority	Member	SE	95% CI	Non-member	SE	95% CI
Wildlife*	2.50	0.08	0.16	1.92	0.12	0.24
Lease Hunting*	0.82	0.18	0.36	0.25	0.21	0.41
Development*	-2.28	0.11	0.22	-1.74	0.18	0.36
Farming/hay Production	0.51	0.18	0.36	0.41	0.22	0.44
Livestock Production	2.14	0.12	0.24	1.82	0.18	0.36
Priority	Small	SE	95% CI	Large	SE	95% CI
Wildlife*	2.13	0.12	0.24	2.42	0.08	0.17
Lease Hunting*	-0.07	0.08	0.36	1.28	0.19	0.37
Development	-2.05	0.18	0.36	-2.07	0.12	0.24
Farming/hay Production*	-0.38	0.27	0.54	0.9	0.15	0.30
Livestock Production*	1.12	0.25	0.50	1.39	0.09	0.18
Priority	North	SE	95% CI	South	SE	95% CI
Wildlife*	2.05	0.13	0.26	2.42	0.08	0.16
Lease Hunting*	0.18	0.21	0.41	0.91	0.20	0.39
Development	-2.18	0.14	0.28	-2.03	0.14	0.28
Farming/hay Production	0.59	0.18	0.36	0.25	0.22	0.44
Livestock Production	2.11	0.14	0.28	1.83	0.17	0.34

Table B5. Mean proportion (%) of WMA members' and non-members' land on which certain management practices were used during last three years (* denotes significant differences) (Fig 9).

Management activity	WMA member	SE	95% CI	Non-member	SE	95% CI
Rotational grazing	41.02	3.33	6.56	34.51	3.90	7.68
Brush control	24.31	2.13	4.20	20.35	2.63	5.18
Erosion control	7.60	1.75	3.45	9.29	2.08	4.10
Native plant restoration	7.20	1.50	2.30	7.33	1.75	3.45
Burning	7.32	1.30	2.56	7.04	1.83	3.61
Overseeding with cover crops*	2.50	0.60	1.18	8.63	2.08	4.10
Food plots	3.15	0.53	1.04	5.12	1.50	2.96
Disking	2.80	0.54	1.06	4.60	1.28	2.52
Other	1.79	0.77	1.52	4.47	1.60	3.15

Table B6. Mean proportion (%) of small and large property owners' land on which certain management practices were used during last three years (* denotes significant differences).

Management activity	Small Property	SE	95% CI	Large Property	SE	95% CI
Rotational grazing*	24.08	3.98	7.84	45.41	3.11	6.13
Brush control	24.78	3.30	6.50	21.77	1.89	3.72
Erosion control	11.01	2.68	5.28	7.11	1.52	2.99
Native plant restoration	7.02	1.93	3.80	7.35	1.40	2.76
Burning	7.27	2.02	3.98	7.21	1.26	2.48
Overseeding with cover crops	7.64	2.05	4.04	3.83	0.99	1.95
Food plots*	7.06	1.93	3.80	2.57	0.48	0.95
Disking	5.07	1.56	3.07	2.69	0.50	0.99
Other	3.04	1.47	2.90	2.79	0.95	1.87

Table B7. Mean proportion (%) of north and south Edwards Plateau residents' land on which certain management practices were used during last three years (* denotes significant differences).

Management activity	North Plateau	SE	95% CI	South Plateau	SE	95% CI
Rotational grazing	43.90	3.80	7.49	34.59	3.56	7.01
Brush control	24.35	2.50	4.93	22.54	2.42	4.77
Erosion control	9.42	2.01	3.96	7.03	1.90	3.74
Native plant restoration	7.64	1.64	3.23	7.03	1.74	3.43
Burning	6.50	1.68	3.31	8.13	1.54	3.03
Overseeding with cover crops*	7.61	1.64	3.23	3.05	1.15	2.27
Food plots	4.70	1.09	2.15	3.50	1.01	1.99
Disking*	5.75	1.18	2.32	1.74	0.54	1.06
Other	4.63	1.59	3.13	1.50	0.68	1.34

Table B8. Index of involvement in government land improvement programs (range = 0 (not involved) to 16).

Survey Group	Mean	SE	95% CI
All Respondents	1.83	0.06	0.12
WMA Members	1.85	0.09	0.16
Non-members	1.77	0.07	0.14
Small Owners	1.81	0.07	0.13
Large Owners	1.85	0.10	0.20
North	1.76	0.08	0.15
South	1.87	0.10	0.19

Table B9. Landowner use of wildlife management practices (number of times, *denotes significant differences).

Management Action	Members	SE	95% CI	Non-members	SE	95% CI
Coyote control*	1.97	0.14	0.27	0.93	0.15	0.28
Feral hog control	1.30	0.14	0.28	1.16	0.16	0.31
Fire ant control	1.47	0.14	0.28	1.23	0.17	0.33
Provide supplemental shelter*	1.71	0.14	0.29	1.00	0.15	0.3
	Small Prop.	SE	95% CI	Large Prop.	SE	95% CI
Coyote control*	0.68	0.14	0.28	1.96	0.13	0.25
Feral hog control*	0.77	0.16	0.31	1.51	0.14	0.27
Fire ant control	1.25	0.19	0.38	1.48	0.13	0.27
Provide supplemental shelter	1.29	0.18	0.36	1.50	0.14	0.27

Table B10. Survey groups' use of deer management practices in deer index (number of times) (Fig. 10).

Survey Group	Mean	SE	95% CI
All Respondents	2.09	0.09	0.18
Member	2.68	0.10	0.20
Non-member	1.20	0.13	0.27
Small	1.42	0.16	0.32
Large	2.42	0.11	0.22
North	2.12	0.14	0.28
South	2.05	0.13	0.27

Table B11. Members' and non-members' use of water conservation actions (number of times, *denotes significant differences) (Fig. 13).

Action	Members	SE	95% CI	Non-members	SE	95% CI
Woody plant control*	1.57	0.14	0.28	0.95	0.14	0.28
Pond construction	1.03	0.11	0.22	0.75	0.13	0.26
Terracing*	0.81	0.12	0.24	0.40	0.11	0.22
Shape waterways	0.63	0.1	0.20	0.46	0.11	0.22
Rainwater harvesting	0.60	0.11	0.22	0.51	0.12	0.24
Reseed with native plants	0.57	0.09	0.18	0.48	0.11	0.22
Improve streamside buffers	0.50	0.09	0.18	0.32	0.10	0.20
Exclude livestock from streamsides	0.33	0.08	0.16	0.42	0.11	0.22

Table B12. Small and large property owners' use of water conservation actions (number of times, *denotes significant differences).

Action	Small	SE	95% CI	Large	SE	95% CI
Woody plant control*	0.92	0.15	0.30	1.53	0.13	0.26
Pond construction	0.72	0.14	0.28	1.01	0.11	0.22
Terracing*	0.41	0.11	0.22	0.77	0.12	0.24
Shape waterways	0.49	0.13	0.26	0.61	0.10	0.20
Rainwater harvesting	0.42	0.12	0.24	0.64	0.10	0.20
Reseed with native plants*	0.35	0.09	0.18	0.63	0.10	0.20
Improve streamside buffers*	0.22	0.09	0.18	0.54	0.09	0.18
Exclude livestock from streamsides	0.25	0.09	0.18	0.46	0.09	0.18

Table B13. North and south property owners' use of water conservation actions (number of times, *denotes significant differences).

Action	North	SE	95% CI	South	SE	95% CI
Woody plant control*	1.07	0.14	0.28	1.58	0.16	0.32
Pond construction	0.85	0.13	0.26	1.03	0.13	0.26
Terracing	0.64	0.13	0.26	0.68	0.12	0.24
Shape waterways	0.46	0.11	0.22	0.70	0.12	0.24
Rainwater harvesting	0.70	0.13	0.26	0.46	0.11	0.22
Reseed with native plants	0.40	0.09	0.18	0.65	0.12	0.24
Improve streamside buffers	0.38	0.10	0.20	0.50	0.10	0.20
Exclude livestock from streamsides*	0.24	0.08	0.16	0.54	0.11	0.22

APPENDIX C

DATA TABLES - SURVEY SECTION B

Table C1. Landowner attitudes towards free movement of wildlife and high fences to restrict wildlife (+3 = very important…-3 = not at all important) (Fig. 12).

	Free Movement			High Fences		
Survey Group	Mean	SE	95% CI	Mean	SE	95% CI
All Respondents	1.68	0.11	0.22	-0.96	0.13	0.26
Member	1.72	0.14	0.28	-1.06	0.16	0.32
Nonmember	1.63	0.18	0.35	-0.78	0.22	0.44
Small	2.01	0.16	0.32	-1.45	0.21	0.41
Large	1.53	0.14	0.28	-0.73	0.17	0.33
North	2.03	0.14	0.28	-1.57	0.18	0.35
South	1.34	0.18	0.35	-0.55	0.19	0.38

Table C2. Member and non-member attitudes towards wildlife management issues (+3 = very important…-3 = not at all important, * denotes significant differences) (Fig. 11).

Issue	WMA member	SE	95% CI	Non-member	SE	95% CI
Woody plant control for wildlife habitat	2.19	0.09	0.18	1.98	0.13	0.26
Free movement of wildlife	1.72	0.14	0.28	1.63	0.18	0.35
Autonomous decision-making	1.69	0.13	0.26	1.66	0.17	0.34
Assistance with wildlife management plans	1.69	0.11	0.22	1.50	0.14	0.28
WMA's for wildlife management*	1.98	0.12	0.24	0.72	0.18	0.35
Use of fire for wildlife habitat*	1.66	0.11	0.22	1.07	0.18	0.35
TPWD	1.52	0.12		1.14	0.17	0.34
Cost-sharing for wildlife habitat	1.33	0.13	0.26	1.15	0.18	0.39
Joint decision-making*	1.42	0.14	0.28	0.77	0.19	0.37
NRCS	0.82	0.14	0.28	0.46	0.19	0.37
USFWS	0.50	0.15	0.30	0.39	0.18	0.36
Improving endangered species habitat	0.23	0.15	0.30	0.43	0.21	0.42
NGO's	-0.32	0.16	0.32	-0.36	0.19	0.37
Conservation easements	-0.64	0.15	0.30	-0.43	0.21	0.42
Public ownership of wildlife	-0.90	0.19	0.37	-0.96	0.23	0.45
High fencing to restrict wildlife	-1.06	0.16	0.32	-0.78	0.22	0.43

Table C3. Small and large property landowner attitudes towards wildlife management issues (+3 = very important…-3 = not at all important, * denotes significant differences).

Issue	Small	SE	95% CI	Large	SE	95% CI
Woody plant control for wildlife habitat*	1.83	0.16	0.32	2.23	0.09	0.18
Free movement of wildlife*	2.01	0.16	0.32	1.53	0.14	0.28
Autonomous decision-making	1.60	0.16	0.32	1.77	0.13	0.26
Assistance with wildlife management plans	1.70	0.14	0.28	1.64	0.11	0.22
WMA's for wildlife management	1.26	0.19	0.37	1.63	0.13	0.26
Use of fire for wildlife habitat*	0.96	0.19	0.37	1.63	0.12	0.24
TPWD	1.52	0.14	0.28	1.31	0.13	0.26
Cost-sharing for wildlife habitat	1.14	0.18	0.35	1.37	0.13	0.26
Joint decision-making	1.12	0.19	0.37	1.20	0.15	0.30
NRCS	0.76	0.16	0.32	0.63	0.15	0.30
USFWS	0.70	0.18	0.35	0.36	0.14	0.28
Improving endangered species habitat*	0.80	0.21	0.41	0.10	0.15	0.30
NGO's*	0.03	0.21	0.41	-0.50	0.15	0.30
Conservation easements*	-0.16	0.22	0.43	-0.75	0.15	0.30
Public ownership of wildlife	-0.68	0.28	0.55	-1.06	0.17	0.33
High fencing to restrict wildlife*	-1.45	0.21	0.41	-0.73	0.17	0.33

Table C4. North and south region landowner attitudes towards wildlife management issues (+3 = very important…-3 = not at all important, * denotes significant differences).

Issue	North	SE	95% CI	South	SE	95% CI
Woody plant control for wildlife habitat	2.19	0.10	0.20	2.04	0.12	0.24
Free movement of wildlife	2.03	0.14	0.28	1.34	0.18	0.35
Autonomous decision-making	1.49	0.16	0.32	1.78	0.14	0.28
Assistance with wildlife management plans	1.74	0.12	0.24	1.51	0.14	0.28
WMA's for wildlife management*	1.75	0.14	0.28	1.19	0.17	0.33
Use of fire for wildlife habitat*	1.18	0.15	0.30	1.72	0.14	0.28
TPWD	1.62	0.14	0.28	1.20	0.15	0.30
Cost-sharing for wildlife habitat	1.45	0.14	0.28	1.15	0.16	0.32
Joint decision-making*	1.32	0.16	0.32	0.94	0.18	0.35
NRCS	0.76	0.16	0.32	0.72	0.16	0.32
USFWS	0.74	0.17	0.33	0.36	0.15	0.30
Improving endangered species habitat	0.44	0.20	0.39	0.31	0.16	0.32
NGO's	-0.23	0.18	0.35	-0.35	0.18	0.35
Conservation easements	-0.69	0.18	0.35	-0.37	0.18	0.35
Public ownership of wildlife	-0.87	0.22	0.43	-1.01	0.21	0.41
High fencing to restrict wildlife	-1.57	0.18	0.35	-0.55	0.19	0.37

Table C5. Members' and non-members' opinions on groundwater management issues (+3= very favorable…-3= very unfavorable, * denotes significant differences).

Issue	Members	SE	95% CI	Non-members	SE	95% CI
Rule of capture	1.53	0.15	0.30	1.14	0.23	0.45
Pumping based on sustainable yield	0.68	0.16	0.32	0.72	0.21	0.41
Evaluating ecological impacts of transfers	0.54	0.17	0.33	0.94	0.19	0.37
Formation of groundwater conservation districts	0.38	0.17	0.33	0.35	0.21	0.41
Evaluating socio-economic impacts of transfers	0.31	0.17	0.33	0.46	0.2	0.39
Groundwater permit system	-0.28	0.18	0.35	0.13	0.25	0.49
Local gov't oversight	-0.14	0.18	0.35	-0.27	0.22	0.43
Your right to buy/sell groundwater	-0.54	0.18	0.35	-0.56	0.22	0.43
Neighbor's right to buy/sell groundwater	-0.68	0.18	0.35	-0.22	0.21	0.41
State gov't oversight	-1.03	0.16	0.32	-0.94	0.19	0.37
Private groundwater cooperatives for marketing	-1.25	0.16	0.32	-0.98	0.19	0.37
Purchase and sale of groundwater	-1.33	0.16	0.32	-1.31	0.19	0.37
Transfer of groundwater from rural to urban	-1.72	0.14	0.28	-1.83	0.17	0.33
Federal gov't oversight	-2.06	0.12	0.24	-1.79	0.17	0.33

Table C6. Small and large property owners' opinions on groundwater management issues (+3= very favorable…-3= very unfavorable, * denotes significant differences).

Issue	Small	SE	95% CI	Large	SE	95% CI
Rule of capture*	1.09	0.20	0.39	1.60	0.17	0.33
Pumping based on sustainable yield	0.73	0.19	0.37	0.76	0.17	0.33
Evaluating ecological impacts of transfers	0.77	0.19	0.37	0.70	0.18	0.35
Formation of groundwater conservation districts	0.25	0.20	0.39	0.54	0.18	0.35
Evaluating socio-economic impacts of transfers	0.42	0.18	0.35	0.39	0.18	0.35
Groundwater permit system	0.15	0.22	0.43	-0.25	0.20	0.39
Local gov't oversight	-0.33	0.21	0.41	-0.02	0.20	0.39
Your right to buy/sell groundwater	-0.56	0.19	0.37	-0.52	0.20	0.39
Neighbor's right to buy/sell groundwater	-0.61	0.19	0.37	-0.64	0.20	0.39
State gov't oversight	-0.92	0.18	0.35	-1.08	0.17	0.33
Private groundwater cooperatives for marketing	-1.19	0.18	0.35	-1.07	0.18	0.35
Purchase and sale of groundwater	-1.35	0.17	0.33	-1.29	0.18	0.35
Transfer of groundwater from rural to urban	-1.81	0.14	0.28	-1.72	0.16	0.32
Federal gov't oversight	-1.91	0.15	0.30	-1.97	0.14	0.28

Table C7. North and south property owners' opinions on groundwater management issues (+3= very favorable…-3= very unfavorable, * denotes significant differences).

Issue	North	SE	95% CI	South	SE	95% CI
Rule of capture	1.17	0.20	0.39	1.57	0.18	0.35
Pumping based on sustainable yield	0.58	0.20	0.39	0.79	0.18	0.35
Evaluating ecological impacts of transfers	0.76	0.20	0.39	0.59	0.18	0.35
Formation of groundwater conservation districts	0.35	0.22	0.43	0.42	0.18	0.35
Evaluating socio-economic impacts of transfers	0.47	0.21	0.41	0.28	0.18	0.35
Groundwater permit system	-0.13	0.23	0.45	-0.18	0.22	0.43
Local gov't oversight	-0.38	0.22	0.43	-0.04	0.20	0.39
Your right to buy/sell groundwater	-0.74	0.20	0.39	-0.44	0.20	0.39
Neighbor's right to buy/sell groundwater	-0.87	0.20	0.39	-0.53	0.20	0.39
State gov't oversight	-1.16	0.17	0.33	-0.88	0.19	0.37
Private groundwater cooperatives for marketing	-1.30	0.19	0.37	-0.97	0.18	0.35
Purchase and sale of groundwater*	-1.61	0.16	0.32	-1.12	0.19	0.37
Transfer of groundwater from rural to urban	-1.73	0.17	0.33	-1.74	0.15	0.30
Federal gov't oversight	-1.92	0.15	0.30	-1.95	0.15	0.30

APPENDIX D

DATA TABLES - SURVEY SECTION C

Table D1. Importance to non-members of reasons for not joining a Wildlife Management Association (+3 = very important…-3 = not at all important) (Fig. 14).

Reason	Mean	SE	95% CI
Don't want to give up control of land	2.40	0.11	0.21
Don't see economic benefit	0.78	0.15	0.29
Don't have time	0.47	0.14	0.28
Don't believe in cooperative mgm't	0.45	0.16	0.32
Property large enough by itself	0.32	0.16	0.32
Don't trust neighbors	0.16	0.15	0.29
Association poorly organized	0.03	0.10	0.20
Not interested in managing for wildlife	-0.03	0.21	0.41
Want a high fence	-0.52	0.20	0.40

Table D2. Likelihood of respondents to join a Groundwater Marketing Association (Fig. 15).

Response	Percent
Very likely	5.5
Possibly	12.0
Uncertain	35.6
Unlikely	20.7
Very unlikely	26.2

Table D3. Respondents agreement with reasons for not joining a Groundwater Marketing Association (+3 = strongly agree…-3 = strongly disagree, *denotes significant differences) (Fig. 16).

Reason	Member	SE	95% CI	Nonmember	SE	95% CI
Not interested in selling groundwater*	1.76	0.14	0.27	1.27	0.20	0.39
Don't think it's ethical*	1.25	0.15	0.29	0.75	0.18	0.36
Don't think joint marketing can work*	0.78	0.14	0.27	0.31	0.15	0.30
Don't have time or interest to join	0.19	0.13	0.25	0.47	0.15	0.29
Don't believe in cooperative mgm't	0.08	0.14	0.28	0.18	0.16	0.31
Don't think there is economic benefit	0.44	0.13	0.26	0.53	0.13	0.25
Don't want to limit my groundwater extraction	0.94	0.14	0.271	0.76	0.17	0.343
Don't trust other members to comply*	0.79	0.13	0.257	0.39	0.14	0.276

Table D4. Member and non-member scores on groundwater marketing "disagreement index" (+3 = strongly agree with reasons not to join…-3 = strongly disagree).

Survey Group	Mean Response Value	SE	95% CI
Members	1.24	0.12	0.24
Non-members	0.84	0.15	0.30

APPENDIX E

DATA TABLES - SURVEY SECTION D

Table E1. Involvement of survey groups in community and natural resource organizations (* denotes significant difference) (Fig. 17).

	Members	SE	95% CI	Non-members	SE	95% CI
Community Organizations*	5.12	0.25	0.49	4.02	0.29	0.56
Natural Resource Organizations*	1.35	0.10	0.19	0.91	0.10	0.19
	Small	SE	95% CI	Large	SE	95% CI
Community Organizations*	3.57	0.28	0.56	5.17	0.24	0.47
Natural Resource Organizations*	0.72	0.10	0.20	1.39	0.09	0.18
	North	SE	95% CI	South	SE	95% CI
Community Organizations	4.41	0.28	0.56	4.8	0.27	0.53
Natural Resource Organizations	1.12	0.10	0.20	1.49	0.11	0.22

Table E2. Respondent involvement in community organizations (2 = very involved… 0 = not involved).

Type of Organization	Mean	SE	95% CI
Church groups	1.22	0.05	0.09
Ranch/farm organizations	0.93	0.05	0.09
Other	0.93	0.13	0.26
Youth-oriented groups	0.59	0.05	0.09
Education/school groups	0.58	0.05	0.09
Community government	0.55	0.05	0.09
Athletic/recreation groups	0.48	0.05	0.09
Civic organizations	0.41	0.05	0.09

Table E3. Percent of respondents involved in natural resource organizations.

Organization	Mean	SE	95% CI
Texas Farm Bureau	0.45	0.03	0.04
Soil and Water Conservation District	0.18	0.02	0.04
Texas Wildlife Association	0.18	0.02	0.04
Ducks Unlimited	0.07	0.02	0.04
The Nature Conservancy	0.04	0.01	0.02
Texas Deer Association	0.04	0.01	0.02
Other	0.04	0.01	0.02
Audubon Society	0.03	0.01	0.02
Coastal Conservation Association	0.03	0.01	0.02
Society for Range Management	0.03	0.01	0.02
National Wild Turkey Federation	0.02	0.01	0.02
National Wildlife Federation	0.02	0.01	0.02
Conservation Easement	0.02	0.01	0.02
The Wildlife Society	0.01	0.01	0.02
Quail Unlimited	0.01	0.01	0.02
Sierra Club	0.01	0.01	0.02
Land Trust Alliance	0.00	0.00	0.00

Table E4. Trust and reciprocity results for survey groups (range +3 to -3, * denotes significant differences) (Fig. 18).

	Members	SE	95% CI	Non-members	SE	95% CI
Trust	1.38	0.09	0.18	1.12	0.12	0.24
Reciprocity	-0.05	0.11	0.22	-0.34	0.13	0.26
	Small	SE	95% CI	Large	SE	95% CI
Trust*	0.95	0.13	0.26	1.43	0.09	0.18
Reciprocity	-0.31	0.13	0.26	-0.08	0.11	0.22
	North	SE	95% CI	South	SE	95% CI
Trust	1.23	0.11	0.22	1.30	0.10	0.20
Reciprocity	-0.17	0.13	0.26	-0.25	0.12	0.24

Table E5. Opinions of WMA members and non-members of social capital statements (+3 = strongly agree…-3 = strongly disagree, * denotes significant differences).

Statement	Members	SE	95% CI	Non-members	SE	95% CI
Generally speaking, most people can be trusted	1.38	0.10	0.20	1.34	0.12	0.24
I know most of the people in the area that I live	1.27	0.11	0.22	1.05	0.16	0.32
I often socialize with landowners in my area*	1.19	0.12	0.24	0.52	0.18	0.36
I consider many people in the area that I live to be friends	1.62	0.11	0.22	1.47	0.14	0.28
I trust the people in the area that I live	1.65	0.09	0.18	1.54	0.11	0.22
I would provide time to help non-kin landowners in my area	1.66	0.09	0.18	1.38	0.11	0.22
I would loan equipment to help non-kin landowners in my area	0.87	0.13	0.26	0.67	0.16	0.32
I would lend money to help non-kin landowners in my area	-0.99	0.13	0.26	-1.36	0.15	0.30
If leading landowners in my area urged others to follow land conservation practices, most would voluntarily comply	0.48	0.12	0.24	0.3	0.12	0.24
If leading landowners in my area urged others to follow deer hunting guidelines, most would voluntarily comply*	0.78	0.13	0.26	0.34	0.15	0.30

Table E6. Opinions of small- and large property owners of social capital statements (+3 = strongly agree…-3 = strongly disagree, * denotes significant differences).

Statement	Small	SE	95% CI	Large	SE	95% CI
Generally speaking, most people can be trusted	1.28	0.11	0.22	1.48	0.11	0.22
I know most of the people in the area that I live	1.02	0.14	0.28	1.35	0.12	0.24
I often socialize with landowners in my area*	0.73	0.15	0.30	1.14	0.14	0.28
I consider many people in the area that I live to be friends*	1.29	0.13	0.26	1.83	0.11	0.22
I trust the people in the area that I live	1.53	0.10	0.20	1.72	0.10	0.20
I would provide time to help non-kin landowners in my area*	1.38	0.10	0.20	1.69	0.10	0.20
I would loan equipment to help non-kin landowners in my area	0.76	0.13	0.26	0.83	0.15	0.30
I would lend money to help non-kin landowners in my area	-1.25	0.14	0.28	-0.98	0.14	0.28
If leading landowners in my area urged others to follow land conservation practices, most would voluntarily comply	0.32	0.13	0.26	0.51	0.12	0.24
If leading landowners in my area urged others to follow deer hunting guidelines, most would voluntarily comply	0.59	0.14	0.28	0.63	0.14	0.28

Table E7. Opinions of north and south survey groups of social capital statements (+3 = strongly agree…-3 = strongly disagree, * denotes significant differences).

Statement	North	SE	95% CI	South	SE	95% CI
Generally speaking, most people can be trusted	1.34	0.11	0.22	1.38	0.11	0.22
I know most of the people in the area that I live	1.2	0.14	0.28	1.18	0.14	0.28
I often socialize with landowners in my area	0.91	0.15	0.30	0.91	0.15	0.30
I consider many people in the area that I live to be friends	1.46	0.14	0.28	1.62	0.12	0.24
I trust the people in the area that I live	1.60	0.11	0.22	1.60	0.10	0.20
I would provide time to help non-kin landowners in my area	1.54	0.10	0.20	1.54	0.11	0.22
I would loan equipment to help non-kin landowners in my area	0.77	0.15	0.30	0.78	0.15	0.30
I would lend money to help non-kin landowners in my area	-1.16	0.15	0.30	-1.26	0.14	0.28
If leading landowners in my area urged others to follow land conservation practices, most would voluntarily comply	0.34	0.12	0.24	0.45	0.14	0.28
If leading landowners in my area urged others to follow deer hunting guidelines, most would voluntarily comply	0.68	0.14	0.28	0.48	0.15	0.30

APPENDIX F

DATA TABLES - SURVEY SECTION E

Table F1. Mean year of birth of survey groups.

Survey Group	Mean	SE	95% CI
All Respondents	1942.80	0.77	1.52
WMA Members	1942.68	0.9	1.78
Non-members	1943.10	1.37	2.71
Small Owners	1944.61	1.31	2.05
Large Owners	1942.16	0.95	2.27
North	1942.48	1.13	2.23
South	1943.34	1.16	2.29

Table F2. Occupations of survey respondents (Fig. 3).

Occupation	Percent
Retired	29.2
Professional	28.0
Agriculture	25.1
Business Owner	7.0
Service	4.4
Other	3.7
Homemaker	2.6

Table F5. Percent of income from property of survey groups (*denotes significant differences between paired groups) (Fig. 4).

Survey Group	Mean %	SE	95% CI
All Respondents	23.32	1.89	3.72
WMA Members*	28.62	2.69	5.30
Non-members	15.76	2.37	4.67
Small	8.78	2.11	4.16
Large*	30.10	2.47	4.87
North	19.18	2.38	4.69
South	26.53	3.11	6.13

Table F4. Education level of survey respondents (Fig. 6).

Education Level	Percent
B.S. degree	30.8
Some college	22.4
Post-graduate degree	21.0
HS grad or GED	16.8
VoTech	3.5
Less than HS	2.8
No response	2.8
Total	100.1

Table F5. Residence of WMA members and non-members (Fig.7).

Residence	WMA members %	Non-members %
On Property	67.3	43.4
Village or Town	9.1	20.4
Urban Area	22.4	31.9
Other	1.2	4.4
Total	100	100

Table F6. Income of survey groups (1= <$25,000…5= >$100,000).

Survey Group	Mean Response Value	SE	95% CI
All Respondents	3.31	0.08	0.16
WMA Members	3.31	0.10	0.20
Non-members	3.32	0.12	0.24
Small	3.13	0.14	0.28
Large	3.39	0.09	0.18
North	3.28	0.12	0.24
South	3.31	0.11	0.22

Table F7. Mean response values for community involvement, trust, and reciprocity for survey respondents, categorized by residence (Fig. 19)

Place of Residence	Community	SE	95% CI	Trust	SE	95% CI	Reciprocity	SE	95% CI
On property	4.94	0.24	0.47	1.69	0.08	0.16	-0.10	0.12	0.24
Village or town	4.18	0.43	0.85	1.18	0.21	0.41	-0.08	0.19	0.37
Urban area	4.68	0.44	0.87	0.52	0.14	0.28	-0.42	0.16	0.32
Other	4.71	0.84	1.65	0.79	0.39	0.77	-0.29	0.51	1.00

Table F8. Mean response values for community involvement, trust, and reciprocity for survey respondents, categorized by education (Fig. 20).

Education Level	Community	SE	95% CI	Trust	SE	95% CI	Reciprocity	SE	95% CI
Less than HS	3.38	0.80	1.58	1.79	0.37	0.73	0.63	0.39	0.77
HS grad or GED	4.25	0.42	0.83	1.52	0.18	0.35	-0.46	0.25	0.49
Vo/Tech training	4.20	1.04	2.05	1.33	0.28	0.55	0.35	0.20	0.39
Some college	4.94	0.42	0.83	1.32	0.17	0.33	0.18	0.17	0.33
Bachelor's degree	5.01	0.33	0.65	1.23	0.13	0.26	-0.32	0.15	0.30
Post-graduate degree	4.92	0.44	0.87	1.06	0.14	0.28	-0.39	0.17	0.33

Table F9. Mean response values for community involvement, trust, and reciprocity for survey respondents, categorized by occupation (Fig. 21).

Occupation	Community	SE	95% CI	Trust	SE	95% CI	Reciprocity	SE	95% CI
Agriculture	5.88	0.36	0.71	1.94	0.10	0.20	0.79	0.18	0.35
Retired	3.97	0.35	0.69	1.37	0.12	0.24	0.41	0.16	0.32
Service	3.50	0.70	1.38	1.17	0.47	0.93	0.42	0.44	0.87
Small or midsize business owner	4.00	0.54	1.06	0.92	0.34	0.67	0.20	0.27	0.53
Professional	5.00	0.37	0.73	0.88	0.13	0.26	0.17	0.16	0.32
Homemaker	3.71	0.99	1.95	0.50	0.59	1.16	-0.37	0.34	0.67
Other	4.80	1.22	2.40	0.23	0.53	1.04	-1.20	0.47	0.93

Table F10. Mean response values for community involvement, trust, and reciprocity for survey respondents, categorized by income (Fig. 22).

Income	Community	SE	95% CI	Trust	SE	95% CI	Reciprocity	SE	95% CI
< $25k	3.67	0.82	1.62	1.49	0.24	0.47	-0.17	0.30	0.59
$25-50k	4.32	0.38	0.75	1.34	0.17	0.33	-0.45	0.18	0.35
$50-75k	4.65	0.38	0.75	1.52	0.15	0.30	-0.18	0.19	0.37
$75-100k	4.77	0.37	0.73	1.37	0.14	0.28	0.05	0.16	0.32
> $100k	5.62	0.48	0.95	0.83	0.16	0.32	-0.24	0.20	0.39

APPENDIX G

DATA TABLES - SURVEY SECTION F

Table G1. Trust and reciprocity scores of WMA members, based on number of members in association (* denotes too few samples to calculate statistics).

Number of Members	Trust	SE	95% CI	Reciprocity	SE	95% CI
10	2.75	*	*	1.33	*	*
12	0.50	*	*	0.67	*	*
14	-0.25	*	*	-0.33	*	*
15	0.00	*	*	0.33	*	*
16	0.10	*	*	0.10	*	*
18	2.33	0.33	0.65	1.56	0.22	0.43
20	2.08	0.35	0.69	1.39	0.48	0.95
24	1.00	*	*	0.00	*	*
25	1.81	0.41	0.81	-0.83	0.17	0.33
27	2.12	0.63	1.24	-0.33	1.00	1.97
30	1.75	0.23	0.45	0.04	0.28	0.55
35	1.28	0.61	1.20	0.94	0.74	1.46
36	1.25	*	*	-2.00	*	*
40	2.00	0.19	0.37	1.03	0.36	0.71
45	2.38	0.38	0.75	2.17	0.17	0.33
48	2.50	*	*	0.00	*	*
50	1.45	0.21	0.41	0.39	0.18	0.35
52	1.75	*	*	1.33	*	*
60	2.00	0.52	1.02	1.11	0.80	1.58
65	2.25	0.52	1.02	0.78	0.29	0.57
68	1.00	*	*	0.00	8.00	15.76
70	1.13	1.13	2.23	1.16	1.17	2.30
75	2.10	0.36	0.71	0.81	0.34	0.67
80	3.00	*	*	-1.00	*	*
90	2.50	*	*	0.33	*	*
100	1.80	0.29	0.57	0.60	0.30	0.59
118	2.00	0.00	0.00	2.00	*	*
120	2.25	0.00	0.00	1.33	*	*
125	1.25	0.75	1.48	1.50	1.50	2.96
127	1.75	0.00	0.00	1.67	*	*
128	1.88	0.38	0.75	0.00	0.33	0.65
200	1.00	*	*	0.67	*	*

Table G2. Trust and reciprocity scores of WMA members, based on number of years of membership in association (* denotes too few samples to calculate statistics).

Years Member	Trust	SE	95% CI	Reciprocity	SE	95% CI
0	0.10	*	*	*	*	*
1	0.44	0.39	0.77	-0.35	0.56	1.10
2	1.25	0.26	0.51	-0.50	0.43	0.85
3	1.32	0.19	0.37	-0.07	0.32	0.63
4	1.55	0.24	0.47	0.06	0.24	0.47
5	0.80	0.38	0.75	0.21	0.33	0.65
6	1.80	0.33	0.65	-0.29	0.44	0.87
7	0.32	0.41	0.81	0.25	0.92	1.81
8	2.08	0.05	0.10	0.00	0.53	1.04
9	2.50	0.25	0.49	1.00	0.76	1.50
10	2.00	0.25	0.49	0.13	0.41	0.81
11	2.00	1.00	1.97	1.25	1.75	3.45
12	1.38	0.13	0.25	-0.50	0.50	0.99
15	1.75	0.25	0.49	0.06	0.24	0.47
18	2.25	0.50	0.99	1.00	0.50	0.99
19	1.75	*	*	-2.00	*	*
20	1.75	0.58	1.14	0.00	0.76	1.50
22	2.25	0.00	0.00	0.25	0.75	1.48
23	2.75	*	*	-3.00	*	*
25	1.75	*	*	1.00	*	*
26	2.50	*	*	-0.50	*	*
30	2.00	*	*	1.50	*	*

Table G3. Trust and reciprocity scores of WMA members, based on number of meetings per year association holds (* denotes too few samples to calculate statistics).

Number of Meetings	Trust	SE	95% CI	Reciprocity	SE	95% CI
1	1.21	0.43	0.85	0.50	0.29	0.57
2	1.36	0.17	0.33	0.00	0.22	0.43
3	1.51	0.19	0.37	-0.14	0.23	0.45
4	1.79	0.16	0.32	0.29	0.22	0.43
5	1.81	0.32	0.63	-0.06	0.49	0.97
6	1.54	0.29	0.57	-0.14	0.36	0.71
8	2.00	*	*	1.50	*	*
9	2.25	*	*	1.50	*	*
12	0.13	1.38	2.72	-1.75	0.25	0.49

Table G4. Trust and reciprocity scores of WMA members, based on percent of meetings attended (* denotes too few samples to calculate statistics)

% Attendance	Trust	SE	95% CI	Reciprocity	SE	95% CI
0	0.23	0.27	0.53	-1.00	0.44	0.87
8	-1.25	*	*	-1.00	*	*
17	1.63	0.13	0.26	-0.25	1.25	2.46
25	1.63	0.63	1.24	1.00	0.00	0.00
33	0.05	0.84	1.65	-0.40	0.29	0.57
38	2.00	*	*	1.50	*	*
40	0.95	0.90	1.77	0.00	0.33	0.65
50	0.96	0.28	0.55	-0.32	1.25	2.46
60	2.13	0.38	0.75	-0.25	0.68	1.34
67	1.53	0.45	0.89	0.00	0.68	1.34
75	1.18	0.39	0.77	0.10	0.25	0.49
80	2.13	0.38	0.75	-0.25	0.25	0.49
83	1.17	0.08	0.16	0.00	0.58	1.14
100	1.82	0.10	0.20	0.13	0.15	0.30

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